

Cover: Sedco I, the semi-submersible drilling platform Imperial and another company are using in a joint exploration program on the Atlantic coast's Grand Banks Left: Imperial Oil's gas processing plant at Quirk Creek, Alta. can remove 240 tons of sulfur from 90 million cubic feet of natural gas per day

Right: A sample of water is tested from Imperial's \$400,000 biochemical lagoon at Winnipeg refinery. Waste water is treated in the lagoon before being discharged into nearby Red River

Oil and the Environment

Pollution is many things. It is dirty water and a littered beach. It is the disappearance of fish from a creek or stream. It is ear-splitting noise, noxious fumes or offensive smells. It is the destruction of natural species and devastation of the land around us. Pollution is a health problem, an economics problem, a natural resource problem and an aesthetic problem all rolled into one. In sum, it could be described as 'the unfavorable alteration of our surroundings, wholly or largely as a by-product of man's actions'. And it has become obvious that we must all fight pollution if we are to continue living on this earth.

It is not a new fight. The battle against silt in streams, for example, began 8,000 years ago in Mesopotamia where irrigation was invented. London in 1660 was described by the Restoration diarist John Evelyn as having 'her stately head in clowds of smoak and sulphur'. A century ago Montrealers and Torontonians suffered sore eyes from the dust that rose from the unpaved streets. The streets are paved today but pollution is still with us.

In general, pollution is the direct result of more people living in bigger cities, consuming more goods and services and using more energy to maintain a high standard of living. With three billion people on earth, man cannot help but contaminate the environment to some extent. No matter what he does, there is always something left over as waste. Laws can be made to protect the environment, but governments realize that it is impossible to eliminate waste entirely. Even if all industries were shut down, human wastes would still be a major environmental problem. Accordingly, government regulations set limits on the amounts of contaminants that may be discharged into air and water. But such regulations and their enforcement are fairly recent developments. Once there was little, if any, public concern and legislation in this regard.

Yet Imperial Oil's anti-pollution activities go back many years. Separators to remove oil from wastes



were built into Imperial's Dartmouth refinery in 1918. Imperial technicians were studying water quality at Sarnia in the 1920s. During the 1960s Imperial spent more than \$40 million on facilities that directly and indirectly protect the environment. In the 1970s it will spend at least \$100 million more. As industry expands to meet the needs of increased population, control equipment becomes an even more important part of the design of new plants. At Imperial's new refinery at Strathcona near Edmonton, for example, more than \$13 million will be spent on pollution control facilities. Hundreds of millions more will be spent to provide facilities to make fuels with little or no lead content.

Imperial and others in the oil industry realize that control of wastes is the most important way to protect the environment. However, where people are involved perfection is impossible, and there is always the chance of accidents. Serious pollution incidents have resulted from accidents in the oil business. Therefore, while Imperial and the oil industry are continually seeking ways to avoid accidents, they are also working on improved methods of restoring the environment if an accident happens.

Most major companies employ full-time environmental specialists, who spend their days making sure company operations are not damaging to the ecology. Imperial Oil and 11 other companies have formed PACE (Petroleum Association for Conservation of the Canadian Environment), and are jointly working to preserve the land, air and water wherever they are touched by the oil industry. Imperial has conducted a cross-Canada study course in environmental biology for its employees and has compiled for them a glossary of environmental terms, from 'abiotic' to 'zooplankton'.

This booklet concerns water, air and noise pollution. It describes the problems facing Imperial and the oil and petrochemicals industry in the matter of environmental protection, and reports what is being done about those problems.



WATER

Water never wears out. Although it may be unevenly distributed, there is – on or under the surface of the earth, or in the atmosphere – as much water as there was millions of years ago. It is possible that the water you used for your last bath was the same water – thousands of times recycled and thousands of years removed – that Cleopatra used in hers.

The perpetual supply of water exists because of nature's cycle. Water is taken in and given out by all plants and animals, carrying waste materials with it. Then, in the natural course of events, one of two things happens:

It evaporates into the atmosphere to form clouds. The wastes it contains before evaporation are left on the earth or enter the atmosphere. The water returns to earth as fog, rain, sleet or snow; or

It sinks into the ground, taking its wastes with it. Sandy soils filter out part of the wastes and when the water reaches a stream, lake or ocean it is cleansed by the action of oxygen, bacteria, sunlight and dilution.

The conservation of water by nature's own renewal process makes life possible. It is only when man upsets this balance that he must correct it by other means.

Water can accommodate a certain amount of waste but when it becomes overloaded, fish, plants and other desirable wildlife may be killed or driven away; swimming and other recreational activities become unsafe or unpleasant; and the water's taste, color and smell are offensive.

And what is 'waste'? The Canada Water Act of 1970 defines it as 'any-substance that, if added to any waters, would degrade or alter or form part of a process of degradation or alteration of the quality of those waters to an extent that is detrimental to their use by man or by any animal, fish or plant that is useful to man...'

The major sources of water pollution are cities, industries and farms.

The waste from cities and towns includes sewage from houses and other sources discharged into the water through sewer systems. In major cities, it may also include large quantities of salt, spread on the streets during the winter to melt snow.

Industrial wastes may include acids, alkalis, sulfur compounds, hydrocarbons, other chemicals, and suspended solids.

Agricultural pollution includes animal wastes, silt, phosphates, nitrates, pesticides and other chemicals used in farming.

Top: An oil-water separator at an Imperial Oil refinery treats water before returning it to its source Left: Pipe lines crossing rivers or harbors are wrapped in thick concrete and buried to protect them against damage

Water can also be polluted by changing its temperature. This 'thermal' pollution happens when heated water is returned to its source, resulting in a rise in temperature that may harm marine plants and creatures.

The oil industry uses or encounters water in all of its operations. Millions of gallons are used daily in refining. A growing part of oil exploration work is carried out off the shores of oceans and seas. When oil is discovered and brought to the surface from deep underground, water often comes up with it. Large volumes of crude oil and manufactured products are moved in ships. Oil and product pipe lines often cross bodies of water.

Exploration and Production

One of the more widely employed techniques in the search for oil uses explosives set off in surface holes to bounce energy waves off underground rock formations. The echoes of these shock waves, translated into a pattern on paper, help oilmen chart what may be buried deep in the earth. On land dynamite makes the explosions. At sea, gas exploders are usually used. One type employs a mixture of oxygen and propane, ignited by a spark plug in a rubber sleeve. The resulting 'pop' inflates the sleeve like an instant balloon. The sudden expansion is sharp enough to give a reading but does not harm fish or other marine creatures, and the burned gases escape to the surface through a snorkel, thus keeping the water clean. The gas exploder was developed by Esso.

In very shallow waters with thick layers of energyabsorbing ooze on the bottom this technique is not effective. So, in some parts of the world (and on an experimental basis in the Arctic), the oilmen drill holes in the ocean floor, and set off explosions inside them as they do on land.

When the explorers have located an area in which oil is likely to be found, they drill to find if it is there. In ocean operations, drilling is done either from specially-built ships or from giant platforms. In all cases, utmost care is taken to protect the waters. Rigs are equipped with 'blow-out preventers' to stop fluids in the pipe from escaping into the water.

Other precautions are taken, too. The drilling bit



Above: This tower conserves water by cooling and recirculating it. It can handle 30,000 gallons a minute Below: Imperial's Redwater, Alta. fertilizer plants have more than \$4 million in pollution control facilities

itself never even touches the water. The drilling takes place within a steel sleeve that runs from the platform to deep beneath the ocean floor. On a typical offshore drilling rig garbage from the galley, soapy washwater and other wastes are taken from the rig and disposed of ashore.



When an oil field is discovered the same precautions apply. Whether on land or sea, the well must not be permitted to 'blow out' or 'gush'. Special devices in wells and pipe line systems are designed to shut down the oil flow if an accident occurs. In addition to these precautions, Imperial trains its crews in well control practices, although most drillers will never see an uncontrolled well.

To make sure that the special drilling mud, or the oil when it is produced, do not contaminate the environment, oil wells are lined with steel pipe. The salty water called brine that sometimes comes to the surface with crude oil is returned to its original underground site or to some other brine-bearing formation, so it won't contaminate surface water or sweet water.

Oil companies are concerned about oil pollution of the oceans. The U.S. Coast Guard has estimated the amount of oil pollution entering the world's oceans in 1971 at 4.9 million metric tons (other reports, using different criteria, arrive at different estimates). Nearly 2.5 million tons came from industrial and automotive waste oils that are discharged on land and end up in the sea. Perhaps 100,000 tons originated from offshore operations. Just under 2.4 million tons originated from accidents and normal operations of the maritime industry.

In general, reports on the amounts of oil entering the oceans from sources in the maritime industry suggest that about a third of it comes from nontanker vessels like ocean liners and cargo steamers. Tankers, however, are still the single main source and do contribute substantially even though most oil companies strive to keep pollution to an absolute minimum. Great care is taken to avoid spills during loading and unloading. The officers and crews of Esso tankers are thoroughly schooled in pollution avoidance and control procedures. In some ports, specially trained retired tanker captains and chief engineers are hired to board chartered ships in port to ensure that pollution control measures are

followed.

The biggest source of tanker sea pollution results from ballasting and tank cleaning operations. Such oily discharges from a single ship may be small, but the total from all tankers can be significant. These discharges occur on the high seas away from coastal waters except in isolated cases where a vessel blatantly disregards the marine industry's clean seas code, or national or international law. Progress has been made by the tanker industry in reducing this source of offshore sea pollution and work continues to find ways to further reduce it.

The oily discharges from tanker operation originate in the need for a tanker that has discharged her oil cargo to re-fill some of her tanks with water so she will be sea-worthy for her voyage to the next port. Inevitably, much of this ballast water mixes with oil residue from the last load. Before the tanker can take on a new oil cargo her water ballast must be discharged. Since this is generally done into the coastal waters of her next loading port, the ballast water must be clean so as to avoid polluting the environmentally sensitive tidal zone. Therefore, while at sea the tanker must dispose of the ballast water that was loaded into uncleaned cargo tanks; she must also wash other tanks to receive sea water that will remain clean for discharge in a port area.

The tanker industry has developed operating procedures to separate oily residues from the water ballast loaded in uncleaned tanks and from the tank washings. The water is then carefully decanted into the seas and the oily residue retained on board in a slops tank. Where reception and treatment facilities are available at loading ports the oily slops are discharged ashore. In most cases, particularly in the

As part of Imperial's oil spill containment and clean-up program, Edmonton refinery employees practise putting a boom in place on the North Saskatchewan River





high-volume crude trade, the slops are retained on board and fresh crude oil cargo is loaded on top of the slops. In this manner most of the residue from the previous cargo is reclaimed and not discharged into the seas. This mode of operation is called 'loadon-top'. Imperial and the other major oil companies have followed it in their own ocean tankers since 1964 and urge its adoption by all ocean tankers engaged in carriage of persistent oils. About 75 per cent of the world tanker fleet follows this procedure, and the 25 per cent that don't use it account for about 70 per cent of the sea pollution from this operational source. Improved load-on-top procedures - carefully monitored, strictly enforced and universally applied could dramatically reduce pollution of the high seas. This is an attainable goal and the industry is working to achieve it.

To make sure its cargoes are carried safely and with due regard for environmental protection, tankers to be chartered by Esso must submit to pre-charter inspection or provide past performance records for screening – sometimes both. When Esso charters a tanker a clause in the contract obliges the vessel to follow the company's pollution-avoidance guidelines including the load-on-top technique. Where these special procedures and the retention of slops add to costs, the company accepts them.

Imperial's lake and coastal tankers discharge all oily ballast into shore facilities and no ballast is discharged into inland or coastal waters within 100 miles of shore.

All of the company's lake, coastal and ocean tankers are equipped to handle minor oil spills. However, despite all the precautions, accidents sometimes occur. To minimize damage from them, Imperial has organized clean-up teams at all its major operating points, and has compiled a series of detailed manuals so that every man knows exactly what to do in case of an accident. Imperial also coordinates its clean-up capabilities with other oil companies and local authorities. More than 80 oilspill-cooperatives now exist across Canada, and they can pool manpower, equipment, materials and knowledge for any emergency, quickly and efficiently.

The laws in some places do not make shipowners sufficiently liable for damages to people affected by tanker accidents, or even for clean-up costs. In order to protect the public in those areas until responsive international laws are ratified, a large number of petroleum companies and private tanker owners have Above: Tankers at the dock of the Imperial Oil refinery at Montreal East, Que. Oily ballast is discharged into tanks at the river's edge

Below: Imperial refineries run continual tests on the quality of water they return to rivers and lakes. Here researchers check purity of impounded basin water at Montreal East refinery

entered into voluntary agreements to ensure that damaged parties are reasonably and promptly reimbursed or compensated. More than 95 per cent of the world's tanker fleet and 80 per cent of the oil moving in international trade are covered by these voluntary agreements.

Pipe Lines

Most Canadian refineries receive their crude oil by pipe line. In addition, smaller lines take products



from the refineries to major terminals. Pipe lines are built to strict government and industry specifications and are regularly monitored so that if a leak occurs the line may be shut down, or if some surface construction job should venture too near, the construction gang is duly warned and watched. Pipe line builders take special care in putting a line across a river or harbor, where it is vulnerable to accidental damage from shipping. On such water crossings the line is wrapped in thick concrete and buried in a trench below the river or harbor bed, so deep that even a dragged anchor should not damage it.

Refineries

In spite of the tremendous volumes of products they make, oil refineries are not major sources of water pollution. One reason is that oil refining is done in a system that is essentially closed. During processing, the crude oil and the products made from it are confined inside pipes and towers. And in comparison with many other industries, very little of the materials used ever becomes waste. Another reason is good housekeeping; oil products can be dangerous if they are handled improperly, and the people who work in refineries handle them with care.

Large amounts of water are used in refining, but

these amounts are steadily being reduced. At Imperial refineries the water is air-cooled and re-used. At Imperial's Sarnia plant, for instance, one tower can cool 30,000 gallons of water a minute. Such air cooling equipment is further reducing the demand for water.

Water used in refining is eventually returned to its source, but it is treated before it is released. The degree of treatment depends on the extent of contamination. In some cases it needs only primary treatment: removal of oil and solids in settling ponds or basins where the solids sink to the bottom. The water is then skimmed to remove surface oil; the skimmed oil goes back to the refinery for reprocessing and the solids are burned or taken to a waste disposal area.

Some highly concentrated refinery wastes - such as acids, spent caustics and water that is contaminated with sulfides, ammonia and phenols - get separate and special treatment. In one such treatment the contaminated water passes through a 'sour water stripper' which removes the ammonia and sulfides. The residue goes into biological oxidation units where specially-bred bacteria literally eat up the phenol compounds.



Above: University of Calgary researchers conduct experiments on biodegradibility of oil in Arctic conditions. Imperial helped pay for this research Right: Huge 'blow-out preventers' are installed during offshore drilling to protect the oceans from pollution in case of sudden pressure surges



AIR

The odds are you'll never breathe pure air. Pure air is an invisible, odorless mixture of gases. It contains about 78 per cent nitrogen and 21 per cent oxygen. The remaining one per cent is mostly carbon dioxide and argon with traces of neon, helium, xenon, hydrogen, methane, krypton and varying amounts of water vapor. Strictly speaking, air becomes polluted whenever anything is added to this mixture.

Air pollution is a question of degree, depending on whether the contaminants are sufficient to endanger health, to damage plants or animals, or to impair visibility in the case of transportation. On the other hand, air need not be contaminated, in the health hazard sense, to be offensive: if it smells bad, that's a form of pollution.

To scientists, air impurities are generally classified as gases and aerosols. Some of the gases are: – Nitrogen oxides, formed when anything is burned. Their commonest forms are nitrogen dioxide and nitric oxide. When nitrogen dioxide reacts with other gases in sunlight it can damage vegetation, cause sore eyes and reduce visibility.

- Sulfur oxides, which occur mainly in the burning of coal and oil. The commonest form is sulfur dioxide, a colorless gas that can irritate the lungs. During smog, some of this may change to sulfur trioxide and sulfuric acid mist, which are more irritating than sulfur dioxide.

- Carbon monoxide, formed when any carbon-bearing material (wood, charcoal, paper, coal, oil, gas) doesn't burn completely. It is particularly dangerous in closed spaces.

- Hydrocarbons, which are hydrogen and carbon in chemical combination. Oil and natural gas are mixtures of hydrocarbons.

- Aldehydes, particularly formaldehyde, which enter the atmosphere from incinerator smoke, from industrial stacks, and from automobile and diesel exhausts.

Aerosols are suspensions of fine solid or liquid particles in the air, some so small you can't see them. They include smoke, fumes, dusts and mists.

The oil industry encounters and combats air pollution in two major areas of its operations: in manufacturing, which can create dust, smoke and smells; and in the use of petroleum products – smoke and gases result when fuels are burned to produce steam for power generation or industrial use, to heat buildings and operate vehicles and machinery. The oil industry also must cope with the hydrogen sulfide removed from crude oil and natural gas. Where the amounts justify it, the sulfur can be removed and used. Where it is present in small amounts it may be burned if the resulting emissions are kept below permissible levels.

One of the first things you notice in a refinery is the absence of visible oil – just miles of pipe, huge towers and furnaces. You also see almost no smoke,



Top: An operator examines a sample of sulfur produced from the waste sulfide streams at Imperial's Winnipeg

refinery Bottom: A closed-circuit TV system at Imperial Oil's Sarnia refinery permits the operators to keep a close control on the performance of flares. Also, cameras automatically record the flare stacks' operation at 15-minute intervals

despite the tall stacks. Emergency gas flares, for example, are almost always of the smokeless type, in which steam is injected from nozzles, mixing air with the escaping gas to burn it completely.



But refineries use large quantities of water. So, particularly in cold weather, clouds of steam and water vapor are common. These clouds are often mistaken for smoke; in fact, steam and water vapor do not contain air contaminants.

Oil refiners fight air pollution in several ways. Sulfur compounds are burned off safely or are converted into saleable sulfur. Special collectors catch the catalyst dust, given off from the largest refining unit, the fluid catalytic cracker. Carbon monoxide from the same unit is put back to work as fuel, and burned to generate steam.

Many refinery products are highly volatile. They evaporate easily, which means that during storage there's the possibility of large and expensive losses. At the same time, evaporated products can make odors in the atmosphere. Many Imperial refineries have a combined solution to both problems: all large storage tanks holding volatile products will have floating roofs sealed with inflatable synthetic rubber gaskets that look like huge inner tubes. They virtually eliminate evaporation of the tanks' contents.

The products refineries make – heavy fuel oils, domestic fuel oils and automobile gasoline among them – are potential sources of air pollution. Heavy fuels, burned in factories, thermal generating plants, hospitals, large apartment buildings and offices, contain as much as three per cent sulfur. Government regulations in Canada are starting to call for reductions in the sulfur content of heavy fuels burned in metropolitan areas.

To reduce the amount of sulfur in fuel oil is very expensive. Experiments are under way to try to solve the problem in other ways at lower cost. One of these is called flue-gas desulfurization, in which chemical treatment removes the sulfur dioxide before it reaches the atmosphere. An Imperial Oil affiliate, Esso Research and Engineering, has been carrying out a major research program of this kind, in conjunction with several electric power companies in Canada and the United States.

Although the sulfur content of home heating fuel is low, such cities as Toronto and Montreal have established controls on it, too.

Automobile

When the automobile engine turns gasoline into energy to drive the car, it isn't totally efficient. It does not completely burn the fuel, with the result that hydrocarbons, carbon monoxide and a variety of other chemical compounds go into the atmosphere.

There are three sources of emissions from an automobile that is not fitted with pollution controls. Some 15 per cent of the emissions come from the fuel tank and from carburetor evaporation. Another 20 per cent originate in the crankcase. The rest, along with carbon monoxide, nitrogen oxides and lead compounds, come from the exhaust.

Automobile manufacturers have made considerable progress in design changes to control these emissions. The car of 1970, properly equipped and maintained, gave off 70 per cent less carbon monoxide and hydrocarbons than the 1960 car.

But the aim for the middle-to-late 1970s – to meet expected government regulations – is an essentially pollution-free car. Automobile companies and oil companies are working toward this. Esso Research and Engineering, for example, has developed a catalytic reactor which in tests has achieved 85 per cent control of nitrogen oxides and 90 per cent for hydrocarbons and carbon monoxide exhaust emissions.

The task poses some challenging problems. One kind of control under consideration is a thermal reactor that would almost totally burn up exhaust gases at very high temperatures. But this in turn calls for special heat-resistant metals. A catalytic reactor, using a catalyst to nullify the pollutants, is more feasible. But tetraethyl lead, which is currently added to gasoline to boost octane ratings, would considerably shorten the life and effectiveness of the catalyst.

There is no medical evidence that lead – in the quantities found in the North American atmosphere – is a health hazard. (Lead as once found in paint, and which small children sometimes licked from their toys, was another matter: it was sometimes found in lethal quantities.) Lead is the most economic means of giving gasoline the boost that modern cars demand.

However, in the early 1970s the oil refiners were faced with the necessity of developing more acceptable gasoline with little or no lead, so that manufacturers' control devices would operate properly. And units to produce high-octane gasolines without lead can cost as much as \$25 million each. Aside from this high expense in facilities to make high-octane gasoline without lead, more crude oil is required to make the same amount of fuel. Inevitably, some of this extra cost will show up in the gasoline prices that motorists will have to pay as part of the price of clean air.

Opposite page: Water cooling towers (foreground) and smokeless flare stacks are two of the many devices used by refineries to help protect the environment Below: Monitoring stations set up by Imperial maintain a constant check on air quality at the company's Sarnia refinery. Here a member of the staff studies data recorded by the monitors



NOISE

Acoustics experts, reporting to the International Standards Organization in Geneva, said that if noise continues to rise at the present rate – about one decibel a year – everyone living in a city could be deaf by the year 2000. Of all the pollutants around us, noise has had the least attention. Yet it is realized now that 'ordinary' everyday noise, over a sustained period, can in some cases impair hearing and erode health in other ways.

For years industry has recognized the noise problem in factories and has taken steps to protect workers from it. Meanwhile, though, the sound level



Imperial Oil industrial hygienist uses sophisticated equipment to measure noise levels at Sarnia refinery

has been rising around all of us in daily life: heavy transports, supersonic aircraft, staccato motorbikes and snow vehicles, shrill motor boats, loud music, rumbling farm machinery, pneumatic drills and all the other clatter of contemporary life. The oil industry is not a leading offender but it is a noise contributor all the same, and noise is now one of its anti-pollution targets.

Perhaps the noisiest part of the oil industry is the refinery with its humming, whistling, rumbling, hissing sounds. Part of the problem, in terms of environment, is the same problem faced by airports: originally, the place was built in a relatively unpopulated area; now, population has closed in around it. So a partial solution to industrial noise – until some future century when technology enables a factory or refinery to do its job in total silence – is proper zoning, with perhaps a buffer zone of light industry or greenbelt between heavy industry and residential areas.

Refiners, nevertheless, must and do keep the noise down, with mufflers on exhaust stacks and vents; acoustically-lined housing on pumps, motors and burners; and, in some locations, sound-deadening walls surrounding noisy units. Sometimes one kind of pollution control inadvertently leads to another kind of pollution. You can burn waste gases completely, without a trace of smoke if you inject steam into the flame. But as the steam content increases, so does the noise level. It is possible to operate a smokeless flare with a minimum of noise, but it takes constant supervision. Consequently, refinery operators monitor the flares to ensure they stay smokeless while operating as quietly as possible. Some refineries use closed-circuit television for this purpose.

During the planning of Imperial's Strathcona refinery in Alberta, the sound level of all potential noises was programmed into a computer and translated into decibels. This information helps to predict the possible noise level of the new plant.

Imperial refineries frequently measure the noise around them, but even so, things sometimes go wrong. In 1971, residents around Imperial's Regina refinery were bothered by a loud noise that was aggravated by easterly winds. The problem was traced to a manufacturing flaw in a brand-new muffler on the exhaust stack of the catalytic cracking unit. A new muffler went up and, throughout the incident, all local residents were kept informed of the cause and the cure in personal letters from the refinery manager.

There are, of course, other noise hazards in the oil industry. Exploration sounds that could disturb northern wildlife will be discussed in this booklet's section on the Arctic. Some Esso car washes have reported that the sound of dryer fans is annoying to neighbours and has to be muffled. The pumps on fuel delivery trucks set up a rumble that sometimes makes windows rattle. So far complaints have been negligible but Imperial has asked equipment suppliers to start making pumps that will lower the noise level.

As yet, however, there are few laws regulating noise and even fewer facilities to measure abuses accurately enough to permit regulations to be written and enforced. Such laws and facilities will come. In the meantime, Imperial will conduct its operations in ways that will not only meet but may improve upon existing or future requirements.

the **ARCTIC**

The noise of a helicopter disturbs the wild geese that nest in large numbers along the Mackenzie delta in Canada's Arctic. As long as 45 minutes before a chopper's arrival, the geese sense its coming and flee from their nests. While they're away from the nests, such predators as foxes and gulls may steal the eggs or eat the young. Result: oil companies have restricted their noise-making activities in main nesting areas during the May-June nesting season.

This is only one of many facts the oil industry is

acting upon in the Arctic. No part of Canada is getting more research attention from the participating oil companies, and from Imperial in particular. For the Arctic is unique, relatively unknown and surprisingly susceptible to damage. It must be treated with uncommon care.

In 1970 Imperial led in the formation of the Arctic Petroleum Operators Association, a group created to sponsor research projects aimed at solving environmental and operational problems in the North. The same year, Imperial co-sponsored a study of bird life in the Mackenzie delta, which helped the Canadian Wildlife Service establish migratory patterns. This information will permit the oil companies to plan their operations in ways and places that will create the least disturbance to birds. Within the company, Imperial has held an Arctic workshop for the instruction of its northern seismic and drilling workers.

Imperial has been exploring the North, off and on, since the early part of this century. It made the first oil discovery in the region in 1920 at Norman Wells, N.W.T., 90 miles south of the Arctic Circle. An

Even in winter special vehicles and techniques are required to protect the frozen tundra



Imperial refinery has operated there since 1932.

The search for oil and natural gas in this vast and forbidding area is totally different from the search in any other part of the country. Quite apart from the problems of cold and transportation, there is the matter of protecting the unusual environment.

The northland is made up of tundra – the treeless area – and the taiga – a Russian word meaning coniferous scrub forest. In either area, but particularly the tundra, the ground cover is fragile. It often is a thin covering of moss and other organic material insulating the frozen ground beneath. If this insulating blanket is destroyed in areas where the permafrost contains a lot of ice, the ground may melt and slump, leaving a deep and possibly permanent scar on the land – and no vegetation. Slumping cannot occur, of course, where the permafrost is dry; for instance, in areas of solid rock, or well-drained gravel.

The ground cover is vital to the ecology of the Arctic, and therefore much research is being devoted to the question of moving equipment over areas of permafrost. Imperial uses tracked and wheeled vehicles in the North only where they will not destroy the plant cover. Vehicles are being developed that won't disturb the vegetation, and until they are available summer seismic work is restricted to areas where the tundra is dry and tough. (Experiments are being conducted with tracked vehicles that 'tread' more lightly, in terms of pressure per square inch, than a man.)

Even winter operations can damage the ground cover if bulldozer blades are set too low when clearing roads and campsites. To alleviate this problem, bulldozers are fitted with "mushroom shoes" to avoid penetration. And the operators are instructed to use a technique known as 'high blading', which moves and compacts snow without destroying vegetation underneath.

Imperial's drilling rigs are supported on wooden piles or on thick gravel pads above the ground, or both – again to protect the ground cover. The heat given off during a drilling operation can thaw the underlying permafrost even in mid-winter. To prevent this, drillers insert a double-walled conductor pipe into the upper part of the hole. They drill through the center while a refrigerant is pumped through coils between the two walls of conductor pipe, to keep the permafrost frozen. Imperial also uses a special lowtemperature drilling mud in the Arctic. When a well is completed and the rig moved away, the site is cleared and the soil and vegetation are put back to preserve the permafrost in its natural state.

Garbage disposal is a problem everywhere, but especially in the North. Some companies bale the waste and fly it by helicopter to dumps at northern communities. Imperial has designed a portable waste disposal plant for seismic and drilling camps. It burns all combustible camp wastes and the ashes are buried in deep holes of small diameter. Whatever the technique, Imperial employees are forbidden to leave litter in the wilderness.

In the event of major oil production in the Arctic the same precautions will be taken with the rigs that develop the fields. But drilling is only one aspect of the petroleum industry. A matter of concern to everyone is the effect of future pipe lines on the tundra.

Like all oil, northern oil comes out of the earth and is transported at temperatures above freezing. Buried pipe lines would therefore need insulation to keep the permafrost from melting. Imperial and others, in a joint study of pipe line construction in the North, operated a test section of 48-inch line near Inuvik, to see how an oil pipe line reacts and how it affects the environment at various temperatures, to study insulation, and to experiment with types of above-ground pipe construction.

An important concern is the effect of pipe lines on animal migrations, particularly the movements of the caribou. In other places, simulated pipe lines have been built high enough for the animals to walk under, and also built so that they can be easily climbed over. The movement of caribou around both kinds is being carefully studied.

Not only pipe lines but every kind of northern transportation is getting special attention. Wherever possible, frozen lakes are used as airstrips. Where these are not available, airstrips are made by laying gravel on top of the tundra without breaking the surface vegetation. Winter roads connecting the airstrips to drill sites are built by the high-blading technique.

Still other kinds of research are devoted to housing and all the attendant problems of living in the North. Getting the oil out without harming the environment is the objective, but there is a side benefit. All of the research is making an enormous contribution to man's overall understanding of the North.

The dilemma of the oil industry, as of any industry today, is how to produce the goods that most people want, at a price they can afford, without degrading the environment.

Why, for example, should oil companies even bother to explore the Arctic or the seas when there is ample oil for the immediate future in conventional reserves? Because, sooner than most people realize Canada will need those additional reserves. Oil and natural gas supply an increasing amount of our energy needs – in Canada, some 70 per cent – and it takes many years to find and develop new reserves.

So the oil search must continue as long as Canadians need oil for home heating, gasoline for automobiles, and petrochemicals for the thousands of other objects of our daily lives. Plants must be built and expanded to manufacture the products. And the search for better anti-pollution measures must likewise go on. This is why Imperial maintains a full-time department of environmental protection. It is why, in addition to all the anti-pollution techniques described in this booklet, the company supports many private researchers, in ventures ranging from a study of the effects of oil on ocean lobster, to the breeding of microbes that may literally eat up oil spills. For Imperial sees its job as helping to meet Canada's growing needs for oil energy and chemicals while conducting its operations in ways that help attain the environmental quality that Canadians require.

On its own, and in conjunction with other companies, Imperial Oil is engaged in research to protect the Arctic Top left: Experimental pipe line tests the effect on Arctic terrain

Top right: A researcher studying fish habitats measures water depths in the Mackenzie delta

Lower left: University of Alberta researcher studies tundra revegetation

Lower right: For summer drilling the permatrost needs protection. Here refrigeration is tried



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British Columbia

1281 West Georgia Street, Vancouver 5, British Columbia

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Environment



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Cover: Sedco I, the semi-submersible drilling platform Imperial and another company are using in a joint exploration program on the Atlantic coast's Grand Banks Left: Imperial Oil's gas processing plant at Quirk Creek, Alta. can remove 240 tons of sulfur from 90 million cubic feet of natural gas per day

Right: A sample of water is tested from Imperial's \$400,000 biochemical lagoon at Winnipeg refinery. Waste water is treated in the lagoon before being discharged into nearby Red River

Oil and the Environment

Pollution is many things. It is dirty water and a littered beach. It is the disappearance of fish from a creek or stream. It is ear-splitting noise, noxious fumes or offensive smells. It is the destruction of natural species and devastation of the land around us. Pollution is a health problem, an economics problem, a natural resource problem and an aesthet problem all rolled into one. In sum, it could be described as 'the unfavorable alteration of our surroundings, wholly or largely as a by-product of man actions'. And it has become obvious that we must al fight pollution if we are to continue living on this earth.

It is not a new fight. The battle against silt in streams, for example, began 8,000 years ago in Mesopotamia where irrigation was invented. London in 1660 was described by the Restoration diarist Joh Evelyn as having 'her stately head in clowds of smoak and sulphur'. A century ago Montrealers and Torontonians suffered sore eyes from the dust that rose from the unpaved streets. The streets are pave today but pollution is still with us.

In general, pollution is the direct result of more people living in bigger cities, consuming more good and services and using more energy to maintain a high standard of living. With three billion people on earth, man cannot help but contaminate the environ ment to some extent. No matter what he does, there is always something left over as waste. Laws can be made to protect the environment, but governments realize that it is impossible to eliminate waste entirely. Even if all industries were shut down, hum wastes would still be a major environmental proble Accordingly, government regulations set limits on the amounts of contaminants that may be discharge into air and water. But such regulations and their enforcement are fairly recent developments. Once there was little, if any, public concern and legislation in this regard.

there was little, if any, public concern and legislation in this regard. Yet Imperial Oil's anti-pollution activities go back many years. Separators to remove oil from wastes



a		
a	were built into Imperial's Dartmouth refinery in 1918.	
n	Imperial technicians were studying water quality at	
	Sarnia in the 1920s, During the 1960s imperial spent	
	more than \$40 million on facilities that directly and	
	indirectly protect the environment. In the 1970s it will	
	spend at least \$100 million more. As industry expands	
elic	to meet the needs of increased population, control	
	equipment becomes an even more important part of	
	the design of new plants. At Imperial's new refinery	
15	at Strathcona near Edmonton, for example, more	
111	than \$13 million will be spent on pollution control	
	racinties. Hundreds of millions more will be spent to	
	provide facilities to make fuels with fittle of no lead	
	Imporial and others in the ail industry realize that	
n	control of wastos is the most important way to	
hn	protect the environment. However, where people are	
9111	involved perfection is impossible, and there is always	
d	the chance of accidents. Serious pollution incidents	
G	have resulted from accidents in the oil business	
bed	Therefore while Imperial and the oil industry are	
ou	continually seeking ways to avoid accidents, they are	
	also working on improved methods of restoring the	
ds	environment if an accident happens.	
	Most major companies employ full-time environ-	
1 C	mental specialists, who spend their days making sure	
n-	company operations are not damaging to the	
е	ecology, Imperial Oil and 11 other companies have	
e	formed PACE (Petroleum Association for Conserva-	
	tion of the Canadian Environment), and are jointly	
	working to preserve the land, air and water wherever	
an	they are touched by the oil industry. Imperial has	
em.	conducted a cross-Canada study course in environ-	
	mental biology for its employees and has compiled	
ed	for them a glossary of environmental terms, from	
	'abiotic' to 'zooplankton'.	
	This booklet concerns water, air and noise pollu-	
on	tion. It describes the problems facing Imperial and	

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WATER

Water never wears out. Although it may be unevenly distributed, there is - on or under the surface of the earth, or in the atmosphere - as much water as there was millions of years ago. It is possible that the water you used for your last bath was the same water - thousands of times recycled and thousands of years removed - that Cleopatra used in hers.

The perpetual supply of water exists because of nature's cycle. Water is taken in and given out by all plants and animals, carrying waste materials with it. Then, in the natural course of events, one of two things happens:

It evaporates into the atmosphere to form clouds. The wastes it contains before evaporation are left on the earth or enter the atmosphere. The water returns to earth as fog, rain, sleet or snow; or

It sinks into the ground, taking its wastes with it. Sandy soils filter out part of the wastes and when the water reaches a stream, lake or ocean it is cleansed by the action of oxygen, bacteria, sunlight and dilution.

The conservation of water by nature's own renewal process makes life possible. It is only when man upsets this balance that he must correct it by other means.

Water can accommodate a certain amount of waste but when it becomes overloaded, fish, plants and other desirable wildlife may be killed or driven away; swimming and other recreational activities become unsafe or unpleasant; and the water's taste, color and smell are offensive.

And what is 'waste'? The Canada Water Act of 1970 defines it as 'any substance that, if added to any waters, would degrade or alter or form part of a process of degradation or alteration of the quality of those waters to an extent that is detrimental to their use by man or by any animal, fish or plant that is useful to man . . .'

The major sources of water pollution are cities, industries and farms.

The waste from cities and towns includes sewage from houses and other sources discharged into the water through sewer systems. In major cities, it may also include large quantities of salt, spread on the streets during the winter to melt snow.

Industrial wastes may include acids, alkalis, sulfur compounds, hydrocarbons, other chemicals, and suspended solids.

Agricultural pollution includes animal wastes, silt, phosphates, nitrates, pesticides and other chemicals used in farming.

Top: An oil-water separator at an Imperial Oil refinery treats water before returning it to its source Left: Pipe lines crossing rivers or harbors are wrapped in thick concrete and buried to protect them against damage

Water can also be polluted by changing its temperature. This 'thermal' pollution happens when heated water is returned to its source, resulting in a rise in temperature that may harm marine plants and creatures.

The oil industry uses or encounters water in all of its operations. Millions of gallons are used daily in refining. A growing part of oil exploration work is carried out off the shores of oceans and seas. When oil is discovered and brought to the surface from deep underground, water often comes up with it. Large volumes of crude oil and manufactured products are moved in ships. Oil and product pipe lines often cross bodies of water.

Exploration and Production

One of the more widely employed techniques in the search for oil uses explosives set off in surface holes to bounce energy waves off underground rock formations. The echoes of these shock waves, translated into a pattern on paper, help oilmen chart what may be buried deep in the earth. On land dynamite makes the explosions. At sea, gas exploders are usually used. One type employs a mixture of oxygen and propane, ignited by a spark plug in a rubber sleeve. The resulting 'pop' inflates the sleeve like an instant balloon. The sudden expansion is sharp enough to give a reading but does not harm fish or other marine creatures, and the burned gases escape to the surface through a snorkel, thus keeping the water clean. The gas exploder was developed by Esso.

In very shallow waters with thick layers of energyabsorbing ooze on the bottom this technique is not effective. So, in some parts of the world (and on an experimental basis in the Arctic), the oilmen drill holes in the ocean floor, and set off explosions inside them as they do on land.

When the explorers have located an area in which oil is likely to be found, they drill to find if it is there. In ocean operations, drilling is done either from specially-built ships or from giant platforms. In all cases, utmost care is taken to protect the waters. Rigs are equipped with 'blow-out preventers' to stop fluids in the pipe from escaping into the water. Other precautions are taken, too. The drilling bit





Above: This tower conserves water by cooling and recirculating it. It can handle 30,000 gallons a minute Below: Imperial's Redwater, Alta. fertilizer plants have more than \$4 million in pollution control facilities

itself never even touches the water. The drilling takes place within a steel sleeve that runs from the platform to deep beneath the ocean floor. On a typical offshore drilling rig garbage from the galley, soapy washwater and other wastes are taken from the rig and disposed of ashore.

When an oil field is discovered the same precautions apply. Whether on land or sea, the well must not be permitted to 'blow out' or 'gush'. Special devices in wells and pipe line systems are designed to shut down the oil flow if an accident occurs. In addition to these precautions, Imperial trains its crews in well control practices, although most drillers will never see an uncontrolled well.

To make sure that the special drilling mud, or the oil when it is produced, do not contaminate the environment, oil wells are lined with steel pipe. The salty water called brine that sometimes comes to the surface with crude oil is returned to its original underground site or to some other brine-bearing formation, so it won't contaminate surface water or sweet water.

Oil companies are concerned about oil pollution of the oceans. The U.S. Coast Guard has estimated the amount of oil pollution entering the world's oceans in 1971 at 4.9 million metric tons (other reports, using different criteria, arrive at different estimates). Nearly 2.5 million tons came from industrial and automotive waste oils that are discharged on land and end up in the sea. Perhaps 100,000 tons originated from offshore operations. Just under 2.4 million tons originated from accidents and normal operations of the maritime industry.

In general, reports on the amounts of oil entering the oceans from sources in the maritime industry suggest that about a third of it comes from nontanker vessels like ocean liners and cargo steamers. Tankers, however, are still the single main source and do contribute substantially even though most oil companies strive to keep pollution to an absolute minimum. Great care is taken to avoid spills during loading and unloading. The officers and crews of Esso tankers are thoroughly schooled in pollution avoidance and control procedures. In some ports, specially trained retired tanker captains and chief engineers are hired to board chartered ships in port to ensure that pollution control measures are

followed.

The biggest source of tanker sea pollution results from ballasting and tank cleaning operations. Such oily discharges from a single ship may be small, but the total from all tankers can be significant. These discharges occur on the high seas away from coastal waters except in isolated cases where a vessel blatantly disregards the marine industry's clean seas code, or national or international law. Progress has been made by the tanker industry in reducing this source of offshore sea pollution and work continues to find ways to further reduce it.

The oily discharges from tanker operation originate in the need for a tanker that has discharged her oil cargo to re-fill some of her tanks with water so she will be sea-worthy for her voyage to the next port. Inevitably, much of this ballast water mixes with oil residue from the last load. Before the tanker can take on a new oil cargo her water ballast must be discharged. Since this is generally done into the coastal waters of her next loading port, the ballast water must be clean so as to avoid polluting the environmentally sensitive tidal zone. Therefore, while at sea the tanker must dispose of the ballast water that was loaded into uncleaned cargo tanks; she must also wash other tanks to receive sea water that will remain clean for discharge in a port area.

The tanker industry has developed operating procedures to separate oily residues from the water ballast loaded in uncleaned tanks and from the tank washings. The water is then carefully decanted into the seas and the oily residue retained on board in a slops tank. Where reception and treatment facilities are available at loading ports the oily slops are discharged ashore. In most cases, particularly in the

As part of Imperial's oil spill containment and clean-up program, Edmonton refinery employees practise putting a boom in place on the North Saskatchewan River





high-volume crude trade, the slops are retained on board and fresh crude oil cargo is loaded on top of the slops. In this manner most of the residue from the previous cargo is reclaimed and not discharged into the seas. This mode of operation is called 'loadon-top'. Imperial and the other major oil companies have followed it in their own ocean tankers since 1964 and urge its adoption by all ocean tankers engaged in carriage of persistent oils. About 75 per cent of the world tanker fleet follows this procedure, and the 25 per cent that don't use it account for about 70 per cent of the sea pollution from this operational source. Improved load-on-top procedures - carefully monitored, strictly enforced and universally applied could dramatically reduce pollution of the high seas. This is an attainable goal and the industry is working to achieve it.

To make sure its cargoes are carried safely and with due regard for environmental protection, tankers to be chartered by Esso must submit to pre-charter inspection or provide past performance records for screening - sometimes both. When Esso charters a tanker a clause in the contract obliges the vessel to follow the company's pollution-avoidance guidelines including the load-on-top technique. Where these special procedures and the retention of slops add to costs, the company accepts them.

Imperial's lake and coastal tankers discharge all oily ballast into shore facilities and no ballast is discharged into inland or coastal waters within 100 miles of shore.

All of the company's lake, coastal and ocean tankers are equipped to handle minor oil spills. However, despite all the precautions, accidents sometimes occur. To minimize damage from them, Imperial has organized clean-up teams at all its major operating points, and has compiled a series of detailed manuals so that every man knows exactly what to do in case of an accident. Imperial also coordinates its clean-up capabilities with other oil companies and local authorities. More than 80 oilspill-cooperatives now exist across Canada, and they can pool manpower, equipment, materials and knowledge for any emergency, quickly and efficiently.

The laws in some places do not make shipowners sufficiently liable for damages to people affected by tanker accidents, or even for clean-up costs. In order to protect the public in those areas until responsive international laws are ratified, a large number of petroleum companies and private tanker owners have

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Above: Tankers at the dock of the Imperial Oil refinery at Montreal East, Que. Oily ballast is discharged into tanks at the river's edge Below: Imperial refineries run continual tests on the quality of water they return to rivers and lakes. Here researchers

check purity of impounded basin water at Montreal East refinery

entered into voluntary agreements to ensure that damaged parties are reasonably and promptly reimbursed or compensated. More than 95 per cent of the world's tanker fleet and 80 per cent of the oil moving in international trade are covered by these voluntary agreements.

Pipe Lines

Most Canadian refineries receive their crude oil by pipe line. In addition, smaller lines take products



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from the refineries to major terminals. Pipe lines are built to strict government and industry specifications and are regularly monitored so that if a leak occurs the line may be shut down, or if some surface construction job should venture too near, the construction gang is duly warned and watched. Pipe line builders take special care in putting a line across a river or harbor, where it is vulnerable to accidental damage from shipping. On such water crossings the line is wrapped in thick concrete and buried in a trench below the river or harbor bed, so deep that even a dragged anchor should not damage it.

Refineries

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In spite of the tremendous volumes of products they make, oil refineries are not major sources of water pollution. One reason is that oil refining is done in a system that is essentially closed. During processing, the crude oil and the products made from it are confined inside pipes and towers. And in comparison with many other industries, very little of the materials used ever becomes waste. Another reason is good housekeeping; oil products can be dangerous if they are handled improperly, and the people who work in refineries handle them with care.

Large amounts of water are used in refining, but

these amounts are steadily being reduced. At Imperial refineries the water is air-cooled and re-used. At Imperial's Sarnia plant, for instance, one tower can cool 30,000 gallons of water a minute. Such air cooling equipment is further reducing the demand for water.

Water used in refining is eventually returned to its source, but it is treated before it is released. The degree of treatment depends on the extent of contamination. In some cases it needs only primary treatment: removal of oil and solids in settling ponds or basins where the solids sink to the bottom. The water is then skimmed to remove surface oil; the skimmed oil goes back to the refinery for reprocessing and the solids are burned or taken to a waste disposal area.

Some highly concentrated refinery wastes - such as acids, spent caustics and water that is contaminated with sulfides, ammonia and phenols - get separate and special treatment. In one such treatment the contaminated water passes through a 'sour water stripper' which removes the ammonia and sulfides. The residue goes into biological oxidation units where specially-bred bacteria literally eat up the phenol compounds.



Oil and the Environment

The odds are you'll never breathe pure air. Pure air is an invisible, odorless mixture of gases. It contains about 78 per cent nitrogen and 21 per cent oxygen. The remaining one per cent is mostly carbon dioxide and argon with traces of neon, helium, xenon, hydrogen, methane, krypton and varying amounts of water vapor. Strictly speaking, air becomes polluted whenever anything is added to this mixture,

Air pollution is a question of degree, depending on whether the contaminants are sufficient to endanger health, to damage plants or animals, or to impair visibility in the case of transportation. On the other hand, air need not be contaminated, in the health hazard sense, to be offensive: if it smells bad, that's a form of pollution.

To scientists, air impurities are generally classified as gases and aerosols. Some of the gases are: - Nitrogen oxides, formed when anything is burned. Their commonest forms are nitrogen dioxide and nitric oxide. When nitrogen dioxide reacts with other gases in sunlight it can damage vegetation, cause sore eyes and reduce visibility.

- Sulfur oxides, which occur mainly in the burning of coal and oil. The commonest form is sulfur dioxide, a colorless gas that can irritate the lungs. During smog, some of this may change to sulfur trioxide and sulfuric acid mist, which are more irritating than sulfur dioxide.

- Carbon monoxide, formed when any carbon-bearing material (wood, charcoal, paper, coal, oil, gas) doesn't burn completely. It is particularly dangerous in closed spaces.

- Hydrocarbons, which are hydrogen and carbon in chemical combination. Oil and natural gas are mixtures of hydrocarbons.

- Aldehydes, particularly formaldehyde, which enter the atmosphere from incinerator smoke, from industrial stacks, and from automobile and diesel exhausts.

Aerosols are suspensions of fine solid or liquid particles in the air, some so small you can't see them. They include smoke, fumes, dusts and mists.

The oil industry encounters and combats air pollution in two major areas of its operations: in manufacturing, which can create dust, smoke and smells; and in the use of petroleum products - smoke and gases result when fuels are burned to produce steam for power generation or industrial use, to heat buildings and operate vehicles and machinery. The oil industry also must cope with the hydrogen sulfide removed from crude oil and natural gas. Where the amounts justify it, the sulfur can be removed and used. Where it is present in small amounts it may be burned if the resulting emissions are kept below permissible levels.

One of the first things you notice in a refinery is the absence of visible oil - just miles of pipe, huge towers and furnaces. You also see almost no smoke,





Top: An operator examines a sample of sulfur produced from the waste sulfide streams at Imperial's Winnipeg refinerv

Bottom: A closed-circuit TV system at Imperial Oil's Sarnia refinery permits the operators to keep a close control on the performance of flares. Also, cameras automatically record the flare stacks' operation at 15-minute intervals

despite the tall stacks. Emergency gas flares, for example, are almost always of the smokeless type, in which steam is injected from nozzles, mixing air with the escaping gas to burn it completely.



But refineries use large quantities of water. So, particularly in cold weather, clouds of steam and water vapor are common. These clouds are often mistaken for smoke; in fact, steam and water vapor do not contain air contaminants.

Oil refiners fight air pollution in several ways. Sulfur compounds are burned off safely or are converted into saleable sulfur. Special collectors catch the catalyst dust, given off from the largest refining unit. the fluid catalytic cracker. Carbon monoxide from the same unit is put back to work as fuel, and burned to generate steam.

Many refinery products are highly volatile. They evaporate easily, which means that during storage there's the possibility of large and expensive losses. At the same time, evaporated products can make odors in the atmosphere. Many Imperial refineries have a combined solution to both problems: all large storage tanks holding volatile products will have floating roofs sealed with inflatable synthetic rubber gaskets that look like huge inner tubes. They virtually eliminate evaporation of the tanks' contents.

The products refineries make - heavy fuel oils, domestic fuel oils and automobile gasoline among them - are potential sources of air pollution. Heavy fuels, burned in factories, thermal generating plants, hospitals, large apartment buildings and offices, contain as much as three per cent sulfur. Government regulations in Canada are starting to call for reductions in the sulfur content of heavy fuels burned in metropolitan areas.

To reduce the amount of sulfur in fuel oil is very expensive. Experiments are under way to try to solve the problem in other ways at lower cost. One of these is called flue-gas desulfurization, in which chemical treatment removes the sulfur dioxide before it reaches the atmosphere. An Imperial Oil affiliate, Esso Research and Engineering, has been carrying out a major research program of this kind, in conjunction with several electric power companies in Canada and the United States.

Although the sulfur content of home heating fuel is low, such cities as Toronto and Montreal have established controls on it, too.

Automobile

When the automobile engine turns gasoline into energy to drive the car, it isn't totally efficient. It does not completely burn the fuel, with the result that hydrocarbons, carbon monoxide and a variety of other chemical compounds go into the atmosphere.

There are three sources of emissions from an automobile that is not fitted with pollution controls. Some 15 per cent of the emissions come from the fuel tank and from carburetor evaporation. Another 20 per cent originate in the crankcase. The rest, along with carbon monoxide, nitrogen oxides and lead compounds, come from the exhaust.

Automobile manufacturers have made considerable progress in design changes to control these emissions. The car of 1970, properly equipped and maintained, gave off 70 per cent less carbon monoxide and hydrocarbons than the 1960 car.

But the aim for the middle-to-late 1970s - to meet expected government regulations - is an essentially pollution-free car. Automobile companies and oil companies are working toward this. Esso Research and Engineering, for example, has developed a catalytic reactor which in tests has achieved 85 per cent control of nitrogen oxides and 90 per cent for

hydrocarbons and carbon monoxide exhaust emissions

The task poses some challenging problems. One kind of control under consideration is a thermal reactor that would almost totally burn up exhaust gases at very high temperatures. But this in turn calls for special heat-resistant metals. A catalytic reactor, using a catalyst to nullify the pollutants, is more feasible. But tetraethyl lead, which is currently added to gasoline to boost octane ratings, would considerably shorten the life and effectiveness of the catalyst.

There is no medical evidence that lead - in the quantities found in the North American atmosphere is a health hazard. (Lead as once found in paint, and which small children sometimes licked from their toys, was another matter: it was sometimes found in lethal quantities.) Lead is the most economic means of giving gasoline the boost that modern cars demand.

However, in the early 1970s the oil refiners were faced with the necessity of developing more acceptable gasoline with little or no lead, so that manufacturers' control devices would operate properly. And units to produce high-octane gasolines without lead can cost as much as \$25 million each. Aside from this high expense in facilities to make high-octane gasoline without lead, more crude oil is required to make the same amount of fuel. Inevitably, some of this extra cost will show up in the gasoline prices that motorists will have to pay as part of the price of clean air.

Opposite page: Water cooling towers (foreground) and smokeless flare stacks are two of the many devices used by refineries to help protect the environment Below: Monitoring stations set up by Imperial maintain a constant check on air quality at the company's Sarnia refinery. Here a member of the staff studies data recorded by the monitors



NOISE

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36 Acoustics experts, reporting to the International Standards Organization in Geneva, said that if noise continues to rise at the present rate - about one decibel a year - everyone living in a city could be deaf by the year 2000. Of all the pollutants around us, noise has had the least attention. Yet it is realized now that 'ordinary' everyday noise, over a sustained period, can in some cases impair hearing and erode health in other ways.

For years industry has recognized the noise problem in factories and has taken steps to protect workers from it. Meanwhile, though, the sound level



Imperial Oil industrial hygienist uses sophisticated equipment to measure noise levels at Sarnia refinery

has been rising around all of us in daily life: heavy transports, supersonic aircraft, staccato motorbikes and snow vehicles, shrill motor boats, loud music, rumbling farm machinery, pneumatic drills and all the other clatter of contemporary life. The oil industry is not a leading offender but it is a noise contributor all the same, and noise is now one of its anti-pollution targets.

Perhaps the noisiest part of the oil industry is the refinery with its humming, whistling, rumbling, hissing sounds. Part of the problem, in terms of environment, is the same problem faced by airports: originally, the place was built in a relatively unpopulated area; now, population has closed in around it. So a partial solution to industrial noise until some future century when technology enables a factory or refinery to do its job in total silence - is proper zoning, with perhaps a buffer zone of light industry or greenbelt between heavy industry and residential areas.

Refiners, nevertheless, must and do keep the noise down, with mufflers on exhaust stacks and vents; acoustically-lined housing on pumps, motors and burners; and, in some locations, sound-deadening walls surrounding noisy units. Sometimes one kind of pollution control inadvertently leads to another kind of pollution. You can burn waste gases completely, without a trace of smoke if you inject steam into the flame. But as the steam content increases, so does the noise level. It is possible to operate a smokeless flare with a minimum of noise, but it takes constant supervision. Consequently, refinery operators monitor the flares to ensure they stay smokeless while operating as quietly as possible. Some refineries use closed-circuit television for this purpose.

During the planning of Imperial's Strathcona refinery in Alberta, the sound level of all potential noises was programmed into a computer and translated into decibels. This information helps to predict the possible noise level of the new plant.

Imperial refineries frequently measure the noise around them, but even so, things sometimes go wrong. In 1971, residents around Imperial's Regina refinery were bothered by a loud noise that was aggravated by easterly winds. The problem was traced to a manufacturing flaw in a brand-new muffler on the exhaust stack of the catalytic cracking unit. A new muffler went up and, throughout the incident, all local residents were kept informed of the cause and the cure in personal letters from the refinery manager.

There are, of course, other noise hazards in the oil industry. Exploration sounds that could disturb northern wildlife will be discussed in this booklet's section on the Arctic. Some Esso car washes have reported that the sound of dryer fans is annoying to neighbours and has to be muffled. The pumps on fuel delivery trucks set up a rumble that sometimes makes windows rattle. So far complaints have been negligible but Imperial has asked equipment suppliers to start making pumps that will lower the noise level.

As yet, however, there are few laws regulating noise and even fewer facilities to measure abuses accurately enough to permit regulations to be written and enforced, Such laws and facilities will come. In the meantime, Imperial will conduct its operations in ways that will not only meet but may improve upon existing or future requirements.

Oil and the Environment

the **ARCTIC**

The noise of a helicopter disturbs the wild geese that nest in large numbers along the Mackenzie delta in Canada's Arctic. As long as 45 minutes before a chopper's arrival, the geese sense its coming and flee from their nests. While they're away from the nests, such predators as foxes and gulls may steal the eggs or eat the young. Result: oil companies have restricted their noise-making activities in main nesting areas during the May-June nesting season.

This is only one of many facts the oil industry is

Even in winter special vehicles and techniques are required to protect the frozen tundra



acting upon in the Arctic. No part of Canada is getting more research attention from the participating oil companies, and from Imperial in particular. For the Arctic is unique, relatively unknown and surprisingly susceptible to damage. It must be treated with uncommon care.

In 1970 Imperial led in the formation of the Arctic Petroleum Operators Association, a group created to sponsor research projects aimed at solving environmental and operational problems in the North. The same year, Imperial co-sponsored a study of bird life in the Mackenzie delta, which helped the Canadian Wildlife Service establish migratory patterns. This information will permit the oil companies to plan their operations in ways and places that will create the least disturbance to birds. Within the company, Imperial has held an Arctic workshop for the instruction of its northern seismic and drilling workers. Imperial has been exploring the North, off and on, since the early part of this century. It made the first oil discovery in the region in 1920 at Norman Wells, N.W.T., 90 miles south of the Arctic Circle. An

Imperial refinery has operated there since 1932.

The search for oil and natural gas in this vast and forbidding area is totally different from the search in any other part of the country. Quite apart from the problems of cold and transportation, there is the matter of protecting the unusual environment.

The northland is made up of tundra – the treeless area – and the taiga – a Russian word meaning coniferous scrub forest. In either area, but particularly the tundra, the ground cover is fragile. It often is a thin covering of moss and other organic material insulating the frozen ground beneath. If this insulating blanket is destroyed in areas where the permafrost contains a lot of ice, the ground may melt and slump, leaving a deep and possibly permanent scar on the land – and no vegetation. Slumping cannot occur, of course, where the permafrost is dry; for instance, in areas of solid rock, or well-drained gravel.

The ground cover is vital to the ecology of the Arctic, and therefore much research is being devoted to the question of moving equipment over areas of permafrost. Imperial uses tracked and wheeled vehicles in the North only where they will not destroy the plant cover. Vehicles are being developed that won't disturb the vegetation, and until they are available summer seismic work is restricted to areas where the tundra is dry and tough. (Experiments are being conducted with tracked vehicles that 'tread' more lightly, in terms of pressure per square inch, than a man.)

Even winter operations can damage the ground cover if bulldozer blades are set too low when clearing roads and campsites. To alleviate this problem, bulldozers are fitted with "mushroom shoes" to avoid penetration. And the operators are instructed to use a technique known as 'high blading', which moves and compacts snow without destroying vegetation underneath.

Imperial's drilling rigs are supported on wooden piles or on thick gravel pads above the ground, or both – again to protect the ground cover. The heat given off during a drilling operation can thaw the underlying permafrost even in mid-winter. To prevent this, drillers insert a double-walled conductor pipe into the upper part of the hole. They drill through the center while a refrigerant is pumped through coils between the two walls of conductor pipe, to keep the permafrost frozen. Imperial also uses a special lowtemperature drilling mud in the Arctic. When a well is completed and the rig moved away, the site is cleared and the soil and vegetation are put back to preserve the permafrost in its natural state.

Garbage disposal is a problem everywhere, but especially in the North. Some companies bale the waste and fly it by helicopter to dumps at northern communities. Imperial has designed a portable waste disposal plant for seismic and drilling camps. It burns all combustible camp wastes and the ashes are buried in deep holes of small diameter. Whatever the technique, Imperial employees are forbidden to leave litter in the wilderness.

In the event of major oil production in the Arctic the same precautions will be taken with the rigs that develop the fields. But drilling is only one aspect of the petroleum industry. A matter of concern to everyone is the effect of future pipe lines on the tundra.

Like all oil, northern oil comes out of the earth and is transported at temperatures above freezing. Buried

pipe lines would therefore need insulation to keep

An important concern is the effect of pipe lines on animal migrations, particularly the movements of the caribou. In other places, simulated pipe lines have been built high enough for the animals to walk under, and also built so that they can be easily climbed over. The movement of caribou around both kinds is being carefully studied.

Not only pipe lines but every kind of northern transportation is getting special attention. Wherever possible, frozen lakes are used as airstrips. Where these are not available, airstrips are made by laying gravel on top of the tundra without breaking the surface vegetation. Winter roads connecting the airstrips to drill sites are built by the high-blading technique.

Still other kinds of research are devoted to housing and all the attendant problems of living in the North. Getting the oil out without harming the environment is the objective, but there is a side benefit. All of the research is making an enormous contribution to man's overall understanding of the North.

The dilemma of the oil industry, as of any industry today, is how to produce the goods that most people want, at a price they can afford, without degrading the environment.

Why, for example, should oil companies even bother to explore the Arctic or the seas when there is ample oil for the immediate future in conventional reserves? Because, sooner than most people realize Canada will need those additional reserves. Oil and natural gas supply an increasing amount of our energy needs – in Canada, some 70 per cent – and it takes many years to find and develop new reserves.

So the oil search must continue as long as Canadians need oil for home heating, gasoline for automobiles, and petrochemicals for the thousands of other objects of our daily lives. Plants must be built and expanded to manufacture the products. And the search for better anti-pollution measures must likewise go on. This is why Imperial maintains a full-time department of environmental protection. It is why, in addition to all the anti-pollution techniques described in this booklet, the company supports many private researchers, in ventures ranging from a study of the effects of oil on ocean lobster, to the breeding of microbes that may literally eat up oil spills. For Imperial sees its job as helping to meet Canada's growing needs for oil energy and chemicals while conducting its operations in ways that help attain the environmental quality that Canadians require.

On its own, and in conjunction with other companies, Imperial Oil is engaged in research to protect the Arctic Top left: Experimental pipe line tests the effect on Arctic terrain

Top right: A researcher studying fish habitats measures water depths in the Mackenzie delta

Lower left: University of Alberta researcher studies tundra revegetation

Lower right: For summer drilling the permafrost needs protection. Here refrigeration is tried



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