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INDUSTRIAL USES OF WATER

NORWAY

NORSK INSTITUTT FOR VANNFORSKNING

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THE WATER POLLUTION COMMITTEE
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N O R W A Y

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Report prepared by Mr. Kjell Baalsrud in August 1956.

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GENERAL INFORMATION

1) Population

Norway has a population of 3.4 million people, the average population density being about 10.5 per sq. km. The main part of the population is living at, or close by the coast; 48 per cent of the population lives in the south east part of the country.

2) Geography

The greater part of Norway consists of high mountain areas, and about 70 per cent of the country is unfit for agricultural or forestrial purposes. The south eastern part differs somewhat in character from the rest of the country, as it comprises wide areas of lowland and forrests.

3. Water courses - run off

The somewhat unusual hydrological and hydrographical conditions are characterized by the changing topography and swiftly flowing rivers. The lakes are generally deep and longitudinal. The average run-off is estimated to 39 litres per second per square km., which corresponds to an average maximum supply of available water of 320 cubic metre per person per day. In a country like Norway, it would of course be impossible to collect all run-off. However, the figures indicate that in general, there is an abundance of water for domestic, industrial and other uses. The run-off from the south eastern part of the country is below the average. In this part of the country, the rivers are flowing less swiftly, and are much longer than in the rest of the country.

4. Water quality

The fresh water in Norway is generally of a soft and oligotrotrophic type. This is a result of a rather cold climate, the properties of the rock and soil, and the short time elapsing between the time of rainfall and outfall to the sea. The water is usually on the acid side, and may be coloured by humus compounds. Typical analyses are shown in Table 3. It is the custom in Norway to consider all running water as healthy. According to an old saying, water coming from the marshes and smaller lakes is considered pure, when it has passed seven stones. However, this situation is not predominant in the polluted areas any longer.

5. Water supply

Ground water is used by isolated farms and dwellings, and a few minor supply systems. Otherwise, surface water is exclusively used. Norway probably uses relatively more surface water than any other country in the world.

The majority of the population uses piped water, and about 50 per cent of the dwellings get water from central water supply systems. The water is generally of a good quality, and is in most cases treated with a weak chlorination only.

6. Water charge

Water for domestic uses is mostly paid according to a fixed charge, which is independent of the amounts of water used. Several small indutries in the towns also pay a fixed charge, but generally, industries pay according to consumption.

The price of piped water is generally governed by the construction costs, especially the cost of transmission systems. Usually, there is no need for pumping stations, as the gathering grounds and reservoirs are usually situated at a sufficiently high level to provide the required pressures by gravity. On the contrary, it is often necessary to provide the mains with pressure reducing installations. The purification cost, if any, is also generelly very low.

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7. Development

The industrial development in Norway has largely taken place during the last 100 years. The development has been particularly rapid after the second world war.

8. Types of industry and their localization

The main industries are based on agriculture, forestry, fishing, mining and water power. The food manufacturing industry, manufacture of pulp and paper basic chemical and basic metal indústires, ship building and repairing, are important industries. Some of the industries are based mainly on export. The localization of recently developed large industries have, among other things, been chosen with due regard to water power and water supply, and have often lead to the formation of new population centra. About 60 per cent fo the industry is located in the south eastern part of the country.

9. Employment

Since the middle of the thirties, manufacturing industry has been the main trade of Norway. Today, 34 per cent of the wage earners work in the industry. The employment of the various groups of industry, may be seen from table 2, in which the industries are classified according to the ISIC system, adapted by the United Nations:

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10. Source of information

General information relating to the use of water by industry, has not previously been collected in the form of statistical data. Even the various group organizations have not gathered such data.

In order to obtain the requisite information, it has therefore been necessary to ask the various establishments separately, and accordingly hereto, a questionaire has been submitted to them. Because of the short time at disposal, and the amount of work involved in filing and interpreting the data, only the establishments with more that 50 wage earners have been questioned.

In the statistical analysis of the returned answers, there is made the assumption that the water consumption per employed person is constant for each group of industry. Obviously, this method is open to much criticism, but it has been found to be the best approach under the present circumstances.

General information on the population and industry of Norway has been obtained from the Statistical Yearbook of Norway, 1955.

It is not likely that water problems of the Norwegian industry can be of any particular interest to countries with limited water supplies. However, the data from Norway may indicate how the industrial uses of water reflect the general conditions under which the industry has to work.

Sea water is used by several industries for various purposes, but sufficient information on the amounts of sea water used is not available.

It has not been possible to give figures for the use of water related to specific industrial products, as this would have required an extensive investigation for which there seems to be little justification in Norway at present.

11. Quantity of water

Data for the total amounts of water used in Norway are listed in table 1. The quantity drawn for domestic use if calculated in the assumption that the average per capita use is 135 litres a day. Although the population is accustomed to a plentiful supply of water, the actual average may be below 135 litres. In the rural districts where piped water is not always available, and where modern sanitary instalments are not yet common, the domestic consumption of water is still low.

The amounts of water used by the individual groups of industry are shown in table 2.

Some industry groups have a low water consumption which mainly constitutes personal and sanitray use of water for workers and employees. The pulp and paper industry draws more than half of the water used by the whole industry. Industries with a high water demand usually have their own supply systems. The amount of water used for cooling and boiler feed can only be estimated for some groups, as in many instances the water used for these purposes is not metered.

12. Quality of water

Only a few establishments have more than one distribution system for water. Hence it is generally required that the supplied water satisfy drinking water standards, even if these are not necessary for the industrial process itself. Exceptions to this rule are particularly encountered where large amounts of cooling or wash water are used.

In the chemical and tanning industry, it is generally desired that the water be as soft as possible. In the pulp and paper industry, it is particularly important that the water be free of suspended particles and contains as little colouring matter (humus, iron) as possible. It is, however, not possible to give figures for the standards of quality required by each group of industry as a result of incomplete information on this point. It appears that the requirements vary within each group.

13. Reclamation of water

In the great majority of establishments, all used water is discharged. When reclamation of water occurs, it is generally either condensed steam returned to the boiler, or cooling water returned via a cooling tower.

The total amount fo reclaimed water cannot be estimated, but it certainly constitutes a very small fraction of the total amount of water by industry.

14. Inadequacy of water supply

Hampering of the industry because of the inadequacy of water, has occurred on several occations. This may be due to either inadequate supply in drought periods, or a periodically changing quality. However, these difficulties are usually a result of low investments in the water supply system and may be overcome by means of rather simple measure. Pollution of water by sewage and industrial wastes have sometimes caused difficulties in the water supply of downstream situated establishments.

15. Water for power production

The power production in Norway is characterized by hydraulic generation of electricity. Electricity from water power is today by far the cheapest source of power.

Several minor installations for the production of electricity from fuel exists, but in general, these are only kept in reserve for cases of breakdown or scarcity of the electrical supply.

The amount of water used for the production of electrical energy is not included in this report:

16. Cost of water

It may be seen from table 2 that self supplied water is much cheaper than water from public supplies. Self supplied water is usually drawn from nearby situated rivers or lakes, and the transmission therefore requires small constructional costs.

17. Published studies

As it is known, there are no studies published which particularly deal with the supply and use of water in industry in this country.

TABLE 1

Water consumption

	Total	Per Capita
Population	3.400.000	1
Employed in industry	344.442	0.10
Gross value of industrial production, kr. per year	14.452.051.000	4.250
Run-off, cubic metre per day	1.090.000.000	320
Public water supply - " - x)	460.000	0.135
Industrial water supply from public supplies, cubic metre per day	657.648	0.20
self supplied, - " -	2.741.560	0.80
total	3.399.208	1.0
per cent used as cooling water	43	
per cent used as boiler fuel	1.7	

Data for the amount of water used for irrigation are not available

x) Estimated for domestic use

TABLE 2

	INDUSTRY TOTAL				INDUSTRIES WHICH HAVE FURNISHED INFORMATION			WATER SUPPLY							
	Number of Establ. mts.	Employed persons Nos.	Employed persons Per cent	Gross value of production Per cent of total	Number of Establ. mts. Answers	Number of Employed persons	Per cent of total no. empl.	Publ.Suppl. cubic metre per day	Self suppl. cubic metre per day	Total cubic metre per day	Per empl. person cubic metre per day	Cooling water per cent	Boiler feed per cent	Charge per cubic metre Publ.Suppl. N.kr.	Charge per cubic metre Self Suppl. N.kr.
12 Metal mining	29	5196	1.5	2.3	8	1568	30	3.450	180.500	183.950	35.4				0.037
20 Food manuf. ind.	5525	43647	12.6	18.2	52	7073	16	382.500	2.310	384.810	11.2			0.156	0.102
21 Beverage industries	135	3162	0.9	2.9	11	2335	74	8.900	420	9.320	2.95	20	52	0.151	
22 Tobacco manuf.	24	1798	0,5	2.4	3	1189	66	333	-	333	0.185			0.20	
23 Manuf. of textiles	613	21838	6.3	5.0	38	4026	18	9.000	19.250	28.250	1.3		7	0.212	0.063
24 Manuf.of footwear, other wear app. etc.	2796	34378	10.0	5.4	49	6678	19	7.300	-	7.300	0.21			0.175	
25 Manuf. of wood and cork, except furniture	4389	19526	5.7	5.1	20	2408	11	7.400	4.720	12.120	0.62		53	0.22	
26 Manuf. of furniture etc.	2856	18431	5.4	2.6	11	1011	55	2.845	420	3.265	0.177		35	0.26	
27 Manuf.of paper and paper pr.	301	22674	6.6	12.3	49	16911	75	4.710	1817.000	1821.710	80.4	5	1	0.184	0.036
28 Printing, publishing etc.	1270	19028	5.5	3.2	17	2054	11	7.000	-	7.000	0.37	40		0.148	
29 Manuf. of leather & leather prod. except footwear	251	2453	0.7	0.6	7	580	24	4.470	2,475	6.945	3.64			0.111	
30 Manuf. of rubber products	154	3829	1.1	0.9	4	2355	61	6.170	-	6.170	0.16	51	7	0.16	
31 Manuf. of chemicals & chem. products	626	19468	5.7	10.6	38	13794	71	126.000	437.000	563.000	23.8	95	22	0.163	0.039
32 Manuf. of prod.of petrol & coal	24	467	0.1	0.3	1	144	31		1.170	1.170	2.50	39	21		
33 Manuf. of other non-metall. mineral prod.	864	12636	3.7	2.3	23	5097	40	34.000	7.100	41.100	3.25			0.178	0.05
34 Basic metal ind.	169	16332	4.7	8.3	31	11957	73	10.350	259.000	269.530	17.1	90		0.142	0.069
35 Manuf. of metal prod. except machinery & trsp.equipm.	1480	20281	5.9	4.1	44	8892	44	11.200	9,940	21.140	1.0	59	1	0.159	0.015
36 Manuf. of machinery, except electr. machinery	682	11204	3.3	2.2	22	2892	26	4.280	19	4.299	0.38		24	0.189	
37 Manuf. of electr. machinery	542	11759	3.4	3.1	18	5773	49	6.510	-	6.510	0.55	76	2	0.173	
38 Manuf. of transp. equipment	2562	45069	13.1	7.2	60	20115	45	18.500	236	18.736	0.42	17		0.175	

TABLE 3

Quality of surface water
Typical examples of chemical composition

		Water supplied from lakes to		Water supplied from large rivers to	
		Oslo[1]	Trondheim	Askim	Kongsberg[2]
Color	mg Pt per litre	15	25	30	22
pH		6.2	6.0	6.8	6.2
Permanganate	mg $KMnO_4$ per litre	16	17	19	15
El. conductivities	per Ohm cm	$3.04 \cdot 10^{-5}$	$4.48 \cdot 10^{-5}$	$3.44 \cdot 10^{-5}$	$1.77 \cdot 10^{-5}$
Residue on evaporation	mg per litre	26	31	-	29
Fixed residue	mg per litre	19.5	25	-	15
Ammonium	mg per litre	<0.05	<0.05	<0.05	<0.05
Nitrate	mg NO_3 per litre	0.7	x)	x)	x)
Nitrite	mg NO_3 per litre	x)	traces	x)	x)
Alkalinity	mg $CaCO_3$ per litre	6	18	23	13
Iron	mg per litre	0.04	<0.04	0.20	<0.04
Manganese	mg per litre	0.01	<0.01	0.01	<0.01
Hardness	mg CaO per litre	5,3	7	8	6
Chloride	mg Cl per litre	1,2	4	0	0
Sulphate		-	x)	x)	x)

1) tap water (chlorination only)

2) supplementary supply

x) not detectable