REMOVING WATER FROM LIGHT OILS BY FILTRATION

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In the refineries of the nation, water removal from petroleum products is accomplished mainly by gravity settling in tanks. This method has a number of disadvantages, including incomplete water removal, product losses when the water bottoms are drained, the large number of tanks required in the refinery, and the corresponding extra inventory of products.

Investigations carried out by the authors in one refinery demonstrated that water bottom-draining from 400 to 700 m^3 light-oil product tanks entailed the following losses at each draining: motor gasoline 160-230 kg, kerosine 480-500 kg, and diesel fuel 1000-1200 kg.

The cost (based on wholesale prices of the industry) of the products lost by a refinery with a crude oil capacity of 6 million tons/yr amounts to about 400,000 roubles.

In the Volgograd Branch of SKB ANN, a method has been developed and tested for removing water from light oils by filtration. Materials used for this purpose include specially treated fibrous, porous, and other filter media.

After passage through the filter layer, the water particles are separated readily from the petroleum products by gravity settling. The flow plan of the test unit is shown in Fig. 1. The fuel-water mixture is prepared in a thermostated container by means of a stirrer.

During the experiments, part of the product is bypassed back to the thermostat before entering the filter-separator.

The flow rate of dewatered product in the system is monitored by means of rotameter readings, and the pressure by means of gage readings.

Water removal results in the laboratory unit are presented in Table 1.

It is evident from Table 1 that the proposed method was highly effective in removing water from diesel and jet fuels. The water content of the influent fuel had no effect on the efficiency of water removal. When the water removal process was carried out at 80°C, the water content of the filter effluent did not exceed 0.045%.

In order to determine the commercial feasibility of removing water from petroleum products by filtration, tests and trial runs were made with 30-liter/h filter-separators.

The tests were carried out in the sampling systems of quality analyzers installed on existing atmospheric-vacuum pipestills and thermal cracking units at a number of refineries. The test conditions and the results obtained are presented in Table 2.

When these filter-separators were put into service in the same refineries, they were found to be highly effective. The annual savings in operating expense obtained by the use of the filters in the quality analyzer systems amounted on the average to 600 roubles per filter, paying off the initial cost within about three months after installation.

In order to try out the method commercially for removing water from light oils at high throughputs, a commercial prototype filter with a capacity of 500 liters/min (30 m^3/h) was developed, built, and tested.

The flow plan of the commercial prototype filter is shown in Fig. 2. The unit consists of four filter-separators of identical design and one tank serving as a settler. The filter-separators are connected through three manifolds—influent, effluent, and waste product; the filters operate in parallel. The flow plan makes it possible to disconnect individual sections of the unit when necessary.

Volgograd Branch of SKB ANN [Special Design Office for Automation of Petroleum Refining and Petrochemistry]. Translated from Khimiya i Tekhnologiya Topliv i Masel, No. 12, pp. 15-17, December, 1967.

TABLE 1.

Product	Product, temp., deg C	Water content, wt.%*		Product flow rate, liters/h
		Ahead of filter	After filter	
Diesel fuel	20	0.5-10	0.009-0.02	36
	30	3.25	0.015	50
	30	1.0	0.013	20
	35	2.2	0.014	20
	40	2.2	0.015	20
	70	1.9-7.5	0.027-0.044	20
	80	5.0	0.045	20
Jet fuel	20	1-13	0.007-0.014	30
	50	2.0	0.014	30
	70	1-9	0.012-0.025	30
	70	30	0.017-0.03	30

*Here and subsequently, the water contents that are listed were determined by the Fischer method.

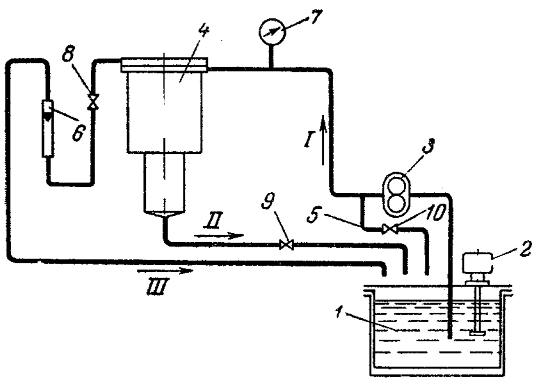

Fig. 1. Flow plan of laboratory unit for removing water from light oils: 1) thermostat; 2) stirrer; 3) gear pump; 4) filter-separator; 5) emulsion bypass; 6) rotameter; 7) gage; 8-10) valves; I) emulsion; II) drain water; III) dewatered product.

Each section of the unit consists of a housing and two filter elements in series.

The filter elements consist of filter beds of fibrous media treated with a special formulation, enclosed in fabric, and mounted on a frame.

The total area of the first-stage filter bed is 1.8 m^2, and that of the second-stage 1.2 m^2.

The process of removing water from a petroleum product is as follows:

The wet product enters the first-stage filter element. As the product passes through the filter bed, the product is demulsified and the water drops coalesce. The enlarged water drops fall by gravity to the lower part of the filter-separator and are drawn off through the waste-product manifold into the settler, along with part of the product. The [major portion of the] product, most of the water having been removed in the first-stage filter bed, then enters the second-stage filter element, which stops all of the water entrained by the flow of the product from the space between the first and second-stage filter beds.

The dewatered product is taken off through the effluent manifold. In the settler, the mixture of petroleum product and water separates into layers. Water is drained from the settler by an automatic device (5, 6).

The system pressure is monitored by gages. The influent and dewatered products are sampled through the valves 10 and 11.

TABLE 2

Product	Product temp., °C	Water content, wt. %		Note
		Ahead of filter	After filter	
Naphtha	20-70	Up to 15	0.01-0.04	When temperature is reduced to 20°C, water content of effluent is reduced to 0.001%.
Jet fuel	25-70	Up to 5	0.002-0.03	
Diesel fuel	25-70	Up to 1	0.005-0.04	

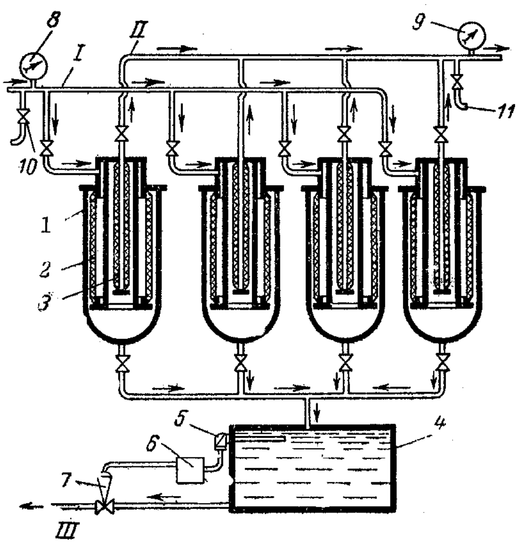

Fig. 2. Flow plan of commercial unit for removing water from light oils: 1) filter-separators; 2) first-stage filter element; 3) second-stage filter element; 4) settler; 5) electrode; 6) transducer; 7) pneumatic valve; 8, 9) gages; 10, 11) sampling valves; I) wet product line; II) dewatered product line; III) drain water.

The results of commercial tests on the filter are presented in Table 3.

It can be seen from Table 3 that coalescence of the fine particles of water was accomplished with equal success under industrial conditions. The filter effluent product was clear and bright and contained only very small amounts of water.

These results confirmed the feasibility of commercial design and operation of filter-separators for efficient removal of water from light oils.

An experimental study was made to determine how long the filter bed material would retain its water-repellency.

The filter bed in question, with a 20-30 mm thickness, removed water efficiently from light oils at a throughput of 5 m^3/h per m^2 filtering surface.

After six months of testing the filters, the water-repellency of the bed coating had not decreased appreciably. During this time, at intervals of one month or longer, the bed material was flushed with the product being filtered, in order to remove solid contaminants that had accumulated on the bed material. After flushing the material, it was used directly, without drying, for further filtration of product. With a 30 m^3/h filter, the flushing operation, including disassembly and reassembly of the filter bed, requires not more than 10 man-hours.

TABLE 3

Sampling date	Product temp., °C	Pressure, kg/cm^2		Water content, wt. %		Product throughput, m^3/h
		Ahead of filter	After filter	Ahead of filter	After filter	
October 25, 1966	50	2.2	1.8	0.042	0.02	15
October 26, 1966	55	2.0	1.7	0.035	0.018	18
October 27, 1966	60	1.8	1.5	0.08	0.012	18
October 28, 1966	65	2.0	1.7	0.049	0.021	21
October 29, 1966	70	2.1	1.9	0.062	0.025	22
October 31, 1966	48	1.6	1.4	0.049	0.018	21
November 1, 1966	65	1.9	1.6	0.075	0.031	23
November 2, 1966	65.	2.3	2.0	0.039	0.025	22
November 3, 1966	65	2.2	1.9	0.046	0.019	22
December 9, 1966	60	1.5	1.2	0.107	0.036	25
December 10, 1966	60	1.5	1.2	0.07	0.03	25

Note: All sections were operating during test.

The cost of the prototype filter-separator (30 m^3/h capacity) was 1013 roubles, including the following: water-repellent fluid 75 roubles, filter element media 38 roubles, frame for filter element and housing of filter element 600 roubles.

These costs could be reduced significantly by a regular production run on the filters.

Calculations indicate that the installation of commercial filters in light-oil streams from atmospheric-vacuum pipestill units of the A-12/1 type will effect annual savings in operating expense totaling 10,000 roubles per filter. The capital costs involved in the installation of such a filter will be paid off in a little more than a month.

SUMMARY

1. A simple and reliable method has been developed for removing water from light oils by means of filtration. The method has been tested under laboratory and commercial conditions.

2. This method is highly effective in removing water from light oils. Further, the water content of the influent product has no effect on the efficiency of water removal.

3. The first experimental lot of filter-separators was used in the sampling systems of light-oil product quality analyzers installed in existing atmospheric-vacuum pipestill units at a number of refineries; these filter-separators gave an average saving of 600 roubles/year per filter and a three-month payoff of initial cost.