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DISPOSAL OF OIL SLUDGE FROM A REFINERY WASTEWATER TREATMENT PLANT

Oil sludge sources at refineries, its quality and utilization methods are discussed. Operating data for oil sludge incineration in fluid bed incinerators, rotary drum kilns, and incinerators equipped with atomizing burners are presented. Incinerators of different design are compared. Various approaches to improve incinerator capacity by the reconstruction of main assemblies as well as operating data for incinerators equipped with rotary burners are presented.

In result of refinery and petrochemical wastewater treatment, a significant quantity of oil sludge is produced the disposal of which has not been solved yet. So far oil sludge has been stored in some refineries.

Oil sludge is formed at large by solids coming into industrial wastewater with make-up water, storm run-off, as a result of pipeline and equipment corrosion, the plant site cleaning as well as by dust blown in form air in the cooling towers, and biological growths in recirculating cooling systems.

The above impurities entering the refinery sewer system and moving along the pipes are coated with petroleum products, and while settling out in the treatment facilities, they form oil sludge which contains up to 10 20% of solids and up to 30% of petroleum products. Oil sludge is also produced in storage tanks for crude, dewatered and desalted oil.

Conventional methods for discharge of oil sludge and its transportation from the treatment facilities result in highly water-diluted oil sludge that enters a gathering pond, solids content being as low as 1–2%. During the accumulation of oil sludge in gathering ponds, petroleum products and water become partially separated. After suitable treatment the separated petroleum product returns to the refinery for the reuse end the water free from settled solids is fed to an oil trap.

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The oil sludge consists of several layers. The upper floating layers contain 40–65% of petroleum products and 2% of solids, while the lower dense ones contain only 13–20% of petroleum products and 15–25% of solids.

In the recent years, biological treatment facilities, producing high amounts (2 m^3 per 100 m^3 of influent wastewater) of waste activated sludge containing 97–98% of water and contributing to the total refinery wastes, have been put in operation by many refineries and petrochemical plants.

A study of different methods of oil sludge utilization (viz. stripping, thickener usage, various solvent extractions, etc) has revealed their incapability of a complete isolation of petroleum product; the content of petroleum product in residual solids being 3–5%, their dumping is not feasible. It appears that it is burning of oil sludge rather than its utilization which is the most efficient and reliable means for a complete oil sludge disposal, since the ash resulting from incineration has no harmful effect.

The Soviet Union has gained a large-scale experience in incineration of the oil sludge in furnaces with bubble burners; the system is simple. The oil sludge is pumped from a gathering pond to a vessel where it is heated, dewatered and then pumped into the kiln. Incinerators with bubble burners are capable of incinerating aged emulsions and oil sludge containing minor quantities of solids (up to 5%) and at least 35–40% of petroleum products, the 1.5 m diameter and 3.5 m high kiln capacity being 5 to 6 t/h (fig. 1). The con-

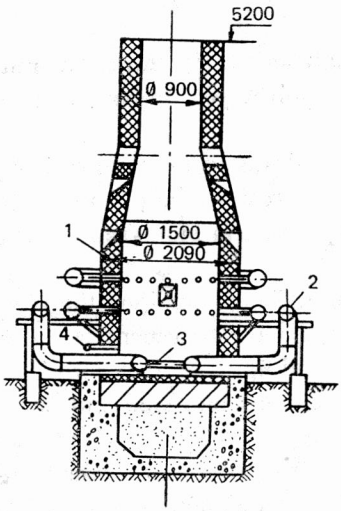

Fig. 1. Kiln with bubble burner

1 — housing, *2* — air supply collector, *3* — bubble burner, *4* — fuel feeding pipeline

Rys. 1. Piec z pęcherzykowym palnikiem

1 — oprawa, *2* — kolektor dostarczający powietrze, *3* — palnik pęcherzykowy, *4* — paliwo zasilające rurociąg

struction of incinerators with bubble burners is simple, they have, however, some limitations. The main one is the lack of ash-catching facilities and periodic shut-downs for slag removal. Some fluid-bed oil sludge incinerators, having a design capacity as high as 1.5 m^3/h (fig. 2), have been constructed in the Soviet Union.

The technological incineration process carried out in such units involves the oil sludge pretreatment in sewage regulators followed by incineration in a sand fluid bed of a ver-

tical kiln. The kiln is equipped with mechanic burners for the atomization of fuel, oil sludge and cooling water. The cooling of off-gases to 250°C was achieved by water injection into the kiln top zone and scrubber. The catching of volatile ash from off-gases took place in the scrubber and a set of cyclones.

The experience gained in operating a fluid-bed incinerator has shown that while incinerating oil sludge with 25–28% of petroleum products and 5–18% of solids, the incinerator capacity was about 1 m^3/h, the fluid bed temperature varied within 400 and 450°C. The attempts of raising the temperature above 450°C were failed for the following reasons:

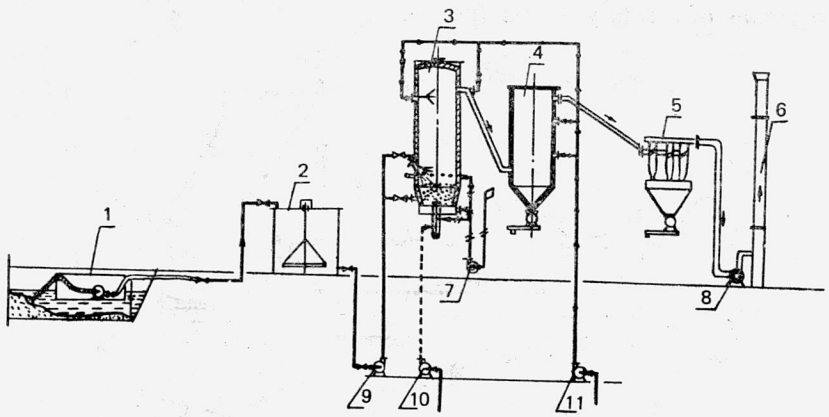

Fig. 2. Oil sludge incineration in a fluid bed

1 — floating pump assembly, *2* — sewage regulator, *3* — vertical kiln (D-2, 6 m, H-8, 5 m), scrubber of VTI type, *5* — battery cyclone, *6* — stack, *7* — air blower, *8* — flue gas blower, *9* — sludge pump, *10* — fuel pump, *11* — water for cooling

Rys. 2. Spalanie osadu olejowego w złożu fluidalnym

1 — zespół pompy flotacyjnej, *2* — regulator ścieków, *3* — piec pionowy (D-2, 6 m, H-8, 5 m), *4* — skruber typu VTI, *5* — cyklon zespołowy, *6* — komin, *7* — dmuchawa powietrza, *8* — dmuchawa spalin, *9* — pompa osadu, *10* — pompa paliwa, *11* — woda do chłodzenia

1) the oil sludge fed into a fluid bed results in gasification of its organic portion followed by the combustion of petroleum product vapours over the mentioned bed;

2) the amount of cold air introduced for fluidization exceeds that required for the sludge burning;

3) the use of cold air for fluidization.

Due to low temperature of the fluid bed, the oil sludge remains unburnet and hence sand and sludge agglomerations are formed.

Supplemental fuel fed both to the fire box and the fluid bed did not raise the temperature of the fluid bed.

To ensure a normal operation of the fluid-bed incinerators for oil sludge, it is necessary to heat the air for fluidization to 600°C, to have a watch incendiary burner above the heat-carrying agent bed. Fluid bed incinerators have not found application in the So-

viet Union in oil sludge disposal but were replaced by box furnaces with pneumatic burners. As the experience has shown, stable operation of these burners is adversely affected by all kinds of foreign matter present in the sludge and often clogging the burners. The use of screens at the feed pump suction does not prevent the clogging but makes the operation rate of pumps much more difficult since the screens must be frequently exchanged. The unstable operation of pneumatic burners affects adversely the sequence of the whole unit operation. Most of these shortcomings do not concern the rotary burner, the performance of which can be affected only by a foreign matter particles of sizes greater than 10 mm.

Construction of one of the operating incinerators was modified adapting it to torch burning by means of a rotary burner (fig. 3).

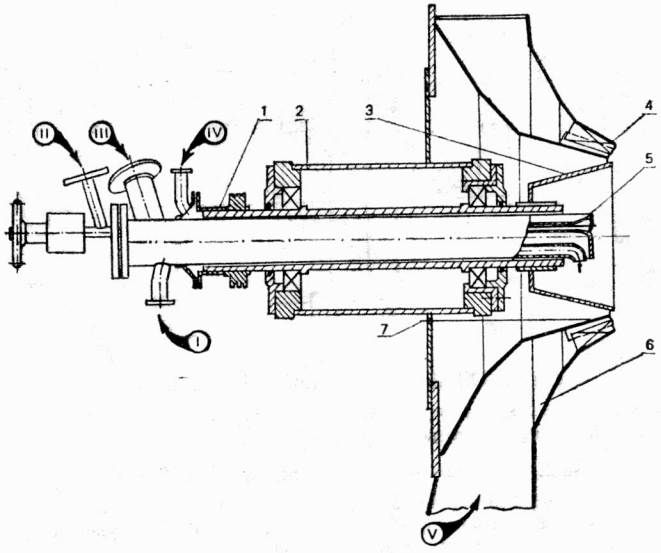

Fig. 3. Flow diagram of rotary burner

1 shaft, *2* — housing, *3* — spray jet, *4* — rotatable blade, *5* — central incendiary burner, *6* — circular air duct, *7* — device for rotation of blades, I — oil sludge, II — fuel oil, III, IV, V — air

Rys. 3. Schemat przepływu w palniku rotacyjnym

1 — wał, *2* — oprawa, *3* — dysza rozpylająca, *4* — łopatki rotacyjne, *5* — centralny palnik zapalający, *6* — kolisty kanał powietrza, *7* — urządzenie powodujące rotację łopatek, I — osad zawierający olej, II — paliwo olejowe, III, IV, V — powietrze

This modernization involved the following procedures: the sludge intake, its pretreatment, feed to the incinerator and its atomization and cooling off-gases.

To remove the oil sludge from gathering ponds, two pumps (screw and sanitary) were installed in series as a part of the floating assembly. The screw pump is submerged into the oil sludge and discharges it into the suction of the sanitary pump to be pumped to the pretreatment. Since, however, the bottom sludge is too high to be sucked in, its feed to the pump suction is possible due to the introduction of a scraper. The screw receiving

window is equipped with a screen to retain major inclusions. On its way to settling tanks the oil sludge is let through a preheater where its temperature rises to 60–80°C due to the direct contact with steam. The heated sludge is settled in a tank, while the separated water is drained into a gathering pond. After the treatment, the average amount of petroleum products of the oil sludge range within 26–34%, and that of solids from 3 to 11%

The oil sludge from the trapped-oil treatment facilities is let to sewage regulators and pumped to combustion.

As the operating experience has shown, it happens very often that mechanical agitators installed in the sewage regulators do not work and the mixing is not satisfactory and the sludge composition not equalized. To maintain a possibly constant composition of sludge fed to the combustion, the oil sludge was recirculated by using a pump.

To ensure the fuel combustion, the rotary burner has a watch incendiary burner operating on supplemental fuel with a consumption of 1–3%. In its lower part, there is a two-layer steam- or air-cooled conic bottom designed for the ash discharge, which is discharged without shutting down the unit.

According to the experience gained in the operation of a vertical furnace, the lining of the latter made of fire-clay brick melts at temperatures higher than 1000°C, especially when alcaline wastes are fed. For this reason the furnace cannot operate longer than 2 to 3 months. Therefore, the lower part (two thirds) of the furnace lining was replaced by the lining made of chromomagnesite brick which increased the lining life up to 17–18 months.

Cooling off-gases is a combined procedure. They are cooled by water injection into the furnace and scrubber, then they are let into air cooler made of ribbed cast iron tubes,

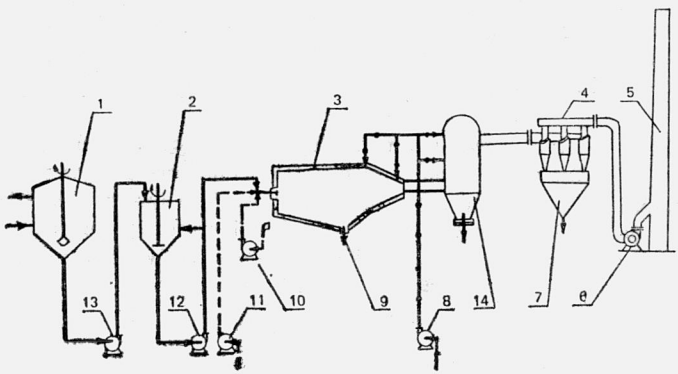

Fig. 4. Flow diagram of oil sludge incinerator

1 — oil sludge pretreatment tank, *2* — sewage regulator, *3* — furnace with a rotary burner, *4* — set of cyclones, *5* — stack, *6* — flue gas blower, *7* — bunker for ash, *8* — water supply, *9* — slag removal, *10* — air blower, *11* — fuel supply, *12–13* — sludge supply, *14* — scrubber

Rys. 4. Schemat blokowy pieca do spopielania osadu zawierającego olej

1 — zbiornik wstępnej obróbki osadu olejowego, *2* — regulator osadu, *3* — piec z palnikiem rotacyjnym, *4* — zespół cyklonów, *5* — komin, *6* — dmuchawa spalin, *7* — zbiornik popiołu, *8* — doprowadzenie wody, *9* — usuwanie żużla, *10* — dmuchawa powietrza, *11* — dostarczanie paliwa, *12–13* — doprowadzenie osadu, *14* — skruber

the dust-carrying off-gases pass through the intertubular space, and the cooling atmospheric air through the tubular space. To clean the ribbed tube surface from ash deposits, a shot blasting device has been mounted. This device causes a complete cleaning of the cooler dusty surfaces by cast iron shot and is switched on once per shift for some minutes.

The above and other improvements of the unit design have made it possible to reach an average capacity of 3.0 t/h, a maximum capacity of 4 t/h being achieveable when burning the sludge containing 25–27% of petroleum products and 5–10% of solids.

The above unit makes possible the disposal of all the oil sludge produced in the refinery. In this way the wastewater treatment effect is improved considerably for the refinery treating facilities.

In the recent years, we have constructed box furnaces equipped with a rotary burner of a capacity of 3–4 t/h, taking account of the operation experience of the first box furnaces.

The flow diagram of an oil sludge incinerator is shown in fig. 4.

From the treatment facilities the oil sludge goes to a pretreatment tank where water excess and petroleum products are removed and then is fed to a sewage regulator. The oil sludge heated to 60–80°C goes from sewage regulator to a rotary burner and is burned in a fire box of the incinerator. The off-gases leaving the incinerator are cooled by water injection, freed from dust in a set of cyclones and discharged into the atmosphere. The ash trapped in a cyclone is accumulated in a bunker and dumped periodically. The above scheme makes possible a most economical incineration of the oil sludge.

To improve the economics of oil sludge incineration, the waste-heat boilers are foreseen in designing incinerators, which will make it possible to profit by steam production.

USUWANIE OSADÓW OLEJOWYCH Z OCZYSZCZALNI ŚCIEKÓW PRZEMYSŁU RAFINERYJNEGO

Omówiono źródła osadów olejowych w rafineriach ropy naftowej, rodzaj i jakość tych osadów oraz metody ich utylizacji. Przedstawiono dane eksploatacyjne spopielania osadów w piecach fluidalnych, rotacyjnych piecach bębnowych i piecach wyposażonych w palniki z dyszami rozpylającymi. Porównano wady i zalety tych rozwiązań i zaprezentowano różne zmiany konstrukcyjne prowadzące do zwiększenia przepustowości tych pieców. Podano również dane eksploatacyjne pieców do spopielania osadów wyposażonych w palniki rotacyjne.

BESEITIGUNG VON ÖLSCHLÄMMEN AUS DEN ARA DER ERÖLRAFFINERIEN

Besprochen werden die Quellen der anfallenden Ölschlämme, deren Art und Zusammensetzung sowie die Verwertungmethoden. Dargestellt werden die Betriebsergebnisse von Veraschung dieser Schlämme in Wirbelschichtöfen, in Trommelöfen und in Düsenbrenneröfen. Die Vor- und Nachteile der o.e. Öfen werden verglichen; vorgeschlagen werden verschiedene, konstruktive Abänderungen, die zu einer größeren Kapazität führen sollen. Beschrieben werden zuletzt die Betriebergebnisse von Veraschungsöfen, die mit Rotationsbrennern ausgestattet waren.

УДАЛЕНИЕ МАСЛЯНЫХ ОСАДКОВ ИЗ ОЧИСТНЫХ СТАНЦИЙ СТОЧНЫХ ВОД НЕФТЕПЕРЕРАБАТЫВАЮЩЕЙ ПРОМЫШЛЕННОСТИ

Обсуждены источники масляных осадков на нефтеперерабатывающем заводе, вид и качество этих осадков, а также методы их утилизации. Представлены эксплуатационные данные сожжения осадков во флюид-печах, ротационных и барабанных печах и в печах, снабжённых горелками с распыляющими соплами. Сравнены недостатки и преимущества этих решений и представлены различные конструкционные изменения, направленные на увеличение пропускной способности этих печей. Приведены также эксплуатационные данные печей для сожжения осадков, снабжённых ротационными горелками.