New Procedures and Methods in Chemical Treatment and Centrifugal Separation Field in Wastes Components of Oil Industry

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The current work present the results of the studies regarding the cleaning of the oil field wastes; the experimental research regarding the chemical pollutants from the oil infested soils, results that define and identify the new solutions and methods of chemical treatment and three-phase separation of the oil wastes. Here are shown such solutions, proposed for, on one side by the chemical treatment of the pollutants coming from the oil slurry and on the other side by the centrifugal and three- phase separation, solids, water and oil of the oil wastes from tanks, infested soils and oil waste pond.

Keywords: oil slurry, chemical pollutants, centrifugal separation

The industrial development, implied an increase of residual wastes, assimilated and reintegrated into the environment, determining the increase of the environmental pollution. At the current level of the technical and technological development, the wastes of this type did not find a corresponding use. Besides other hazards towards the environment, they present an increased toxicity, and occupy an important storage space, their destruction being imposed .

The oil and petrochemical wastes constitute a powerful source of pollution of the environment: air, water, soil [6, 7]. The oil wastes concentrate both the aromatic hydrocarbons as the benzopyrene, benzoanthracene, dibenzoanthracene, etc. that present a cancer action on the human organism, but especially the hetero-compounds with sulphur, nitrogen, oxygen that constitute high risk products of pollution. Other wastes contain the halogenated compounds, ethers, phenol compounds, etc. The non-correspondingly treated wastes and their decomposition products, being washed by precipitation waters, spreaded out and penetrated the soil. Thus, the soil surface is polluted on big surfaces, after which the soil particles contaminated by polluting materials, through the rain, penetrate the phreatic waters or the surface waters nearby (open ditches, streams, rivers, lakes, etc.) [7].

Beginning with 2003, the European Union included as priority the Wastes Management Component, within the Sixth Action Program concerning the Environment, having as purpose the reduction of the generated wastes quantity and a better use of the resources. According to this EU policy [8], three approach strategies are involved in the wastes management that is: removal of the wastes production at the source, encourage the wastes recycling and re-use and wastes incineration if they cannot be recycled and / or used.

Following the activities developed within the oil industry in Romania, beginning with extraction, but especially within the refinery and petrochemical field [2, 3], besides the main products there is also a series of oil wastes (residual products) that were not processed more than 70 years, being stored in areas situated near the industrial generator units. It is estimated that such oil wastes amount to approximately 1.5 million cubic meters, including those of refineries [4].

Out of the various sources of wastes specific to the refinery and petrochemical sector we mention acid tars, used soil (sludge), settlements in the tanks where oil products are settled, used catalysts, various oil wastes, organic solvents, halogenated compounds, macromolecular compounds, used sludge resulted from the biological wastewater treatment plants in the refineries.

A viable solution to settle the wastes issue is represented by the oil wastes co-processing (pre-treatment, separation of valuable products and co-incineration of fuel cakes in cement plants from used oils and emulsions till tars and contaminated soil). The advantages of these procedures consist in wastes removal in safety conditions, environment protection, health and security, natural resources conservation and reduction of greenhouse gas emissions that would be generated in case of storage or incineration of other wastes. The future schemes of the oil processing contain the atmospheric distillation processes, vacuum distillation, propane deasphaltizing of the vacuum waste. Electric power, steam and hydrogen result simultaneously from these types of combined installations. Thus, it is assured the energetic independency of the refineries, having the possibility to deliver the electric power, steam or warm water to other external consumers, and the hydrogen resulted after purification can be used in catalytic refinery processes. The disadvantage of these types of technologies consists in exorbitant costs of such investments. The oil wastes processing by coking and viscosity reduction (“Carbon rejection” technology) represents another processing scheme that implies lower costs, but the products quality is lower, the scheme flexibility more reduced, and the conversion degree lower. Because the sulphure removal issue from the heavy oil and residual products is not realized in an acceptable way, this technology does not settle the environment pollution issues. While in Romania, the recovering and recycling of the useful substances is realized only 2-3% of the annually collected wastes, in the countries of the European Union this is realized in a percentage of 60-70% [4, 5].

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A very important fraction of these wastes is named conventionally “multi-phase mixtures” and results from extracted or imported oil settlements, washing of the oil tanks or crude oil stokers, filtrations realized in different phases of the technological process, residuals resulted from oil processing. This field constitutes, even on the international level, a novelty.

The research and practical achievements are very recent. The “multi-phase mixtures” are spread out on very extensive areas within the territory of the country, which creates difficulties in approaching a project in this field.

Experimental part

The design possibilities are still limited and not always the preliminary data used for the design are identical to the compositions in the field. Within this system, the cost of the installations is very high.

It is understood that this separation method supposes the realization of the simultaneous separation process of all phases that concur to the mixture formation.

As advantages, we can mention a processing, relatively low cost price, and simple supplementary installations. As disadvantages, we mention: complex technological flow professionally managed, the separator design and manufacture requiring a highly qualified working force.

We are exposing below the functioning principle of the centrifugal separation method in one processing, as well as the principle schematic that is the base of the construction of such an aggregate. The multi-phase mixture is introduced at a pressure of 3 – 4 bars by an adduction pipe within the transporter, rotating at 35-40 rot/min., at the level of the accelerator that increases the kinetic energy of the mixture, modifying its direction; then it passes by the supply nozzles to the cylinder settlement compartment.

The settlement cylinder rotates in the same sense with the helicoid transporter and is driven through the belt by the electrical engine at a rotation of approximately 4000 rot/min, and the helicoid transporter is driven by another electrical engine, by means of a planetary reducer. The centrifugal force determines the segregation of the solid part firstly by the gravimetric principle, at the wall of the settlement cylinder while the settled layer is made thicker; this is transported by the helicoid of the slug to the discharge hole situated at the end of the cylinder. The difference of speed of the two moving elements is essential for the separation quality. It will have optimal values for a certain type of mixture.

The liquids are settled to the interior of the cylinder and while the solid is released, they migrate to the other end of the cylinder and are removed by centrifugal valves. The components separated as such are collected in a diaphragm tank and freely removed.

The design principle for the realization of these installations is the centrifugation at a rotation that must be calculated exactly depending on many parameters (a very important one is the composition and the characteristics of the “multi-phase mixture”). The interior of the installation has as main part a transporter cylinder with own rotation, in sense contrary to the exterior one, calculated according to certain principles, that pushes the solid component resulted to an evacuation area. The other two products of the “multi-phase” mixture are selected and evacuated with the help of other devices.

The design and realization of such installations supposes a wide experience in centrifugal machines field. In our country, the only manufacturer of centrifugal machines with special performances (as this installation) is INCDT COMOTI Bucharest that has very important achievements in this field.

The principle that stood at the base of the design and realization of the centrifugal separator, was the centrifuging of the mixture at a calculated speed, depending om the mixture composition (multi-phase mixtures) in a two pieces assembly: cylinder body and the helicoidally transporter that were powered by two electrical motors in the same spinning sense, with the mention that the cylinder speed is with 40 rot/min bigger than the helicoidally transporter.

The interior of the equipment has as main piece a transporter cylinder, which has his own speed, opposing the external one, calculated after some principle, that push the resulted solid component to the evacuation area. The other two products of the “multiphase mixture” processing are selected and evacuated with the help of another device.

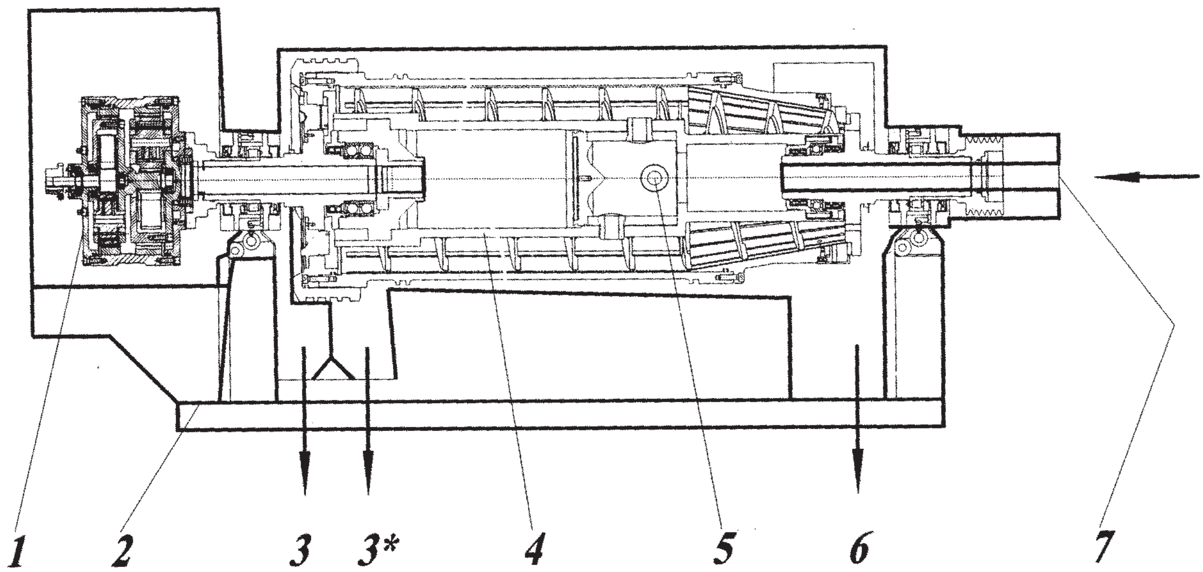

Fig. 1. Schematic of centrifugal separator:
(1 - gearbox assembly; 2 - frame; 3 - water discharge; 3*- oil discharge;
4 - conveyor assembly; 5 - feed zone; 6 - cake discharge; 7 - feed tube)

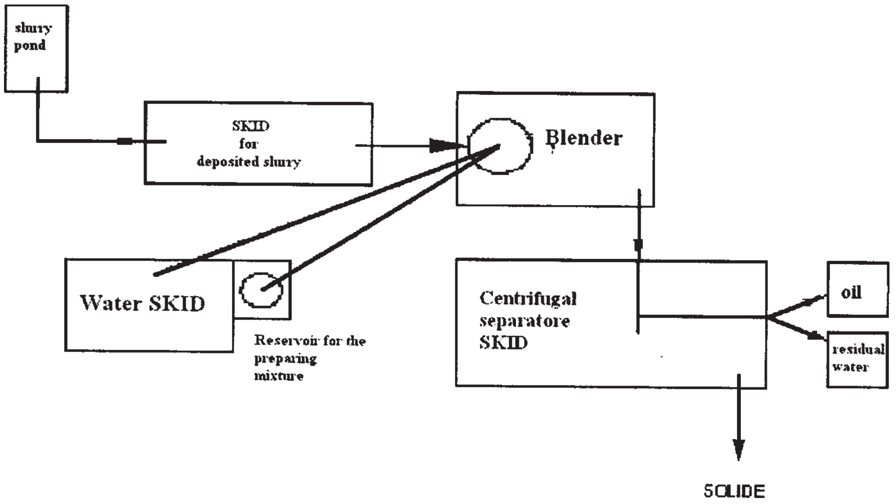

Fig. 2.Schematics of the treatment and centrifugal separation equipment

The main characteristics of the installation are:

Dimensions:	1812 x ø460
Weight:	530 kg
Processed slurry flow:	18 m^3/h
Speed:	3850 rot/min
Differential speed:	35-40 rot/min
Slurry injection pressure:	2-4 bar

Table 1

THE SEPARATED PHASE PROPORTIONS IN THE CHEMICAL TREATMENT EXPERIMENT OF THE SLURRIES

Probe's code	% Separated solid phase	% Liquid oil phase	% Liquid water phase
A – 1	12	68	20
A – 11	16	66	18
A – 111	17	65	18
B – 1	18	56	26
B – 11	18	58	24
B – 111	19	56	25

Results and discussions

In table 1 are presented the separated phases in the chemical treatment of the slurries.

The type A and B slurry have been put under a series of treatments that would make the three phase separation easier. The slurry A, which has in its initial state a medium acidity, has been treated supplementary comparing with slurry B, with a quantity of potassium hydroxide calculated for a concentration of 5% to the entire mass of the slurry. This concentration was enough to reduce to zero the acidity of the treated slurry. The stages of the treatment were:

- the mixture of the slurry probe with water heated at 80°C, to maintain a sufficient high level of the temperature until the end of the treatment. For slurry A, in this water was introduced the potassium hydroxide needed to neutralize the acidity. The resulted mixture has been left for over one hour to realize the separation of the phases. The probes resulted in this treatment have been tagged A-1 and B-1;
- in the second stage it was used instead of simple hot water, the same quantity of water in which has been added a mixture of glycol (mono and dietylenglycol) with the role to increase the separation degree between the two liquid phases by breaking the emulsions that are created between the two phases. The resulted probes are tagged A-11 and B-11;
- in the third stage the treatments from the first and second stages were put on again and the experiment continued through introduction in the mixture of atmospheric distillated diesel oil, in a proportion of 30% of the quantity of slurry. After intense mixture the probes were left to settle. They were tagged A-111 and B-111.

Conclusions

From all the materials studied, we can conclude that the processing of the "multi-phase mixtures" is not fully settled at the international level, the research containing the produced and commercialized installations having an experimental regime, searching for their improvement. The general conclusion of the realized studies consists in the evaluation as a feasible and adequate approach, in Romania too, of some types of research from the field of complex chemical industry and three-phase separation, which will use high tech discoveries. Such technological research complies with the European and international norms in the field, and is qualitatively comparable with the similar investigation installations and techniques on the European or American market.

References

1.MOCANU, B. I., NAUM, N., GRUIA, I., BOMBOS, D., ZAHARIA, E., Rev. Chim.(Bucuresti), **60**, nr. **2**, 2009, p. 193

2.DUMITRESCU, V., DINU, F., , Rev. Chim. (Bucuresti)., **60**, nr. **9**, 2009,p. 967

3.NEACŞU, S., TRIFAN, C., ALBULESCU, M., CALOTĂ, E., Rev. Chim. (Bucuresti)., **57**, nr. 8, 2006, p. 870

4.PLATON, V., MAZILESCU, R., Cost estimate for the national strategy of wastes management, controlled storage of wastes. Synthesis, IEN – ICIM, Bucharest, June 2002

5.TRICA, C., Environment management. Conceptual approaches and case studies. ASE publishing house. Bucharest 2004

6.VIONE, D., CASANOVA, I., MINERO, C., DUNCIANU, M., OLARIU, R.I., ARSENE, C., Rev. Chim. (Bucuresti), **60**, nr. 2, 2009, p. 123

7.VIONE, D., RAVIZZOLI, B., RINALDI, E., PETTINATO, F., ARSENE, C., OLARIU, R.I., Rev. Chim. (Bucuresti), **60**, nr. **3**, 2009, p. 237

8.**** E.C. Delegation to Romania, TA for Implementation of I.P.PC, Directive 360039, 19 RP 135aC, Edition 2, December 17th 2004

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