



Removal of Water Emulsified in Mineral Oil – An Alternative Approach

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Abstract

Mineral oil in metal containments with access of outside air may become contaminated with humidity present in the air because water starts to condense on cold metallic surfaces. An approach for the removal of this water moiety would be to remove it with polysaccharides that have the property of swelling up by water uptake. The polysaccharides can be fixed to carriers such as expanded clay particles. When oil containing water comes in contact with the polysaccharide coat, the water is taken up; the coated carriers containing water can be removed. A device is described that may allow application of this principle.

Keywords: Water in oil; Removal of water; Polysaccharides; Swelling; Water uptake; Device.



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1. Introduction

Water-free mineral oils are used in a huge variety of technical equipment, e.g. as hydraulic oils in machines of construction equipment like excavators, baggers, for forklift trucks, for cooling of transformers etc. Their general properties [1] make them indispensable.

Various approaches are used to keep these mineral oils free of water. Conventional techniques are gravity separation, centrifugation, separation by distillation, i.e. a process of separating the components from a liquid mixture using selective boiling and condensation [2]. It is a matter of the conditions (especially the volume) that determine the kind of separation.

The present Short-Communication describes an alternative approach and the design of a device that may allow to make use of the properties of materials so far not considered for the separation of water from mineral oil. Most probably, this approach might be used for small volumes of water-in-oil mixtures. Its basis is an observation [3] that demonstrated the properties of certain polysaccharides, i.e. swelling-up as soon as they have contact with water. They can take up, by this process, 50 to 300 times the mass of water compared to their own mass. The second component of the device is expanded clay („exclay“). This spherical material, with a size between 6 and 10 mm, contains, inside, many small cavities; they are in contact with pores. Water can be taken up and stored inside. Gardeners use this material to keep the water in the soil. In the device shown below this spherical material is used as the carrier for polysaccharide.

2. Materials and Methods

Expanded clay globules are available in sizes from 2 mm to 16 mm diameter. For the laboratory experiments described below, globules were used with diameters from 6 to 10 mm.

Mineral oil: standard gearbox oil

Polysaccharide: Guar gum powder (galactomannan): It has a remarkable potential for swelling up in the presence of water; values of water weight of 50 times the weight of the powder were measured.

2.1. Preparation of Polysaccharide-Coated Expanded Clay Globules

Into 500 ml water, 3 to 4 g of Guar gum powder were poured, and the mixture was stirred for two to three minutes. Now the stirred mixture was poured into a glass desiccator, and the expanded clay globules were added. With a water jet pump, a slight vacuum was produced. One could observe that air present inside the globules did fizzle out. It can be assumed that water with polysaccharide did penetrate instead. Now the clay globules were taken out of the desiccator. It could be seen that the surface of the globules was coated with a thin layer of wet polysaccharide gel. After air drying of the clay globules they appeared to be coated by a thin layer of dried polysaccharide gel and ready for the experiment.- Meanwhile, the polysaccharide gel had changed into a soft lump and could be thrown away.

It should be noted that the data given above for the various components were just examples that could serve as a basis for optimization.

2.2. Laboratory Experiment

For a demonstration of the effect of removal of water from mineral oil, a laboratory set up was used: a glass cylinder about 25 cm high, with a diameter of 4 cm and a bottom with a faucet was filled with a mixture (80 %, weight) of polysaccharide-coated expanded clay globules and 20 % (weight) uncoated globules. The device was brought in an upright position, and the faucet was opened. An empty glass beaker (500 ml) was put under the faucet. Now, the oil containing emulsified water (300 ml oil, 2 ml water) was poured into the upper end of the cylinder. The

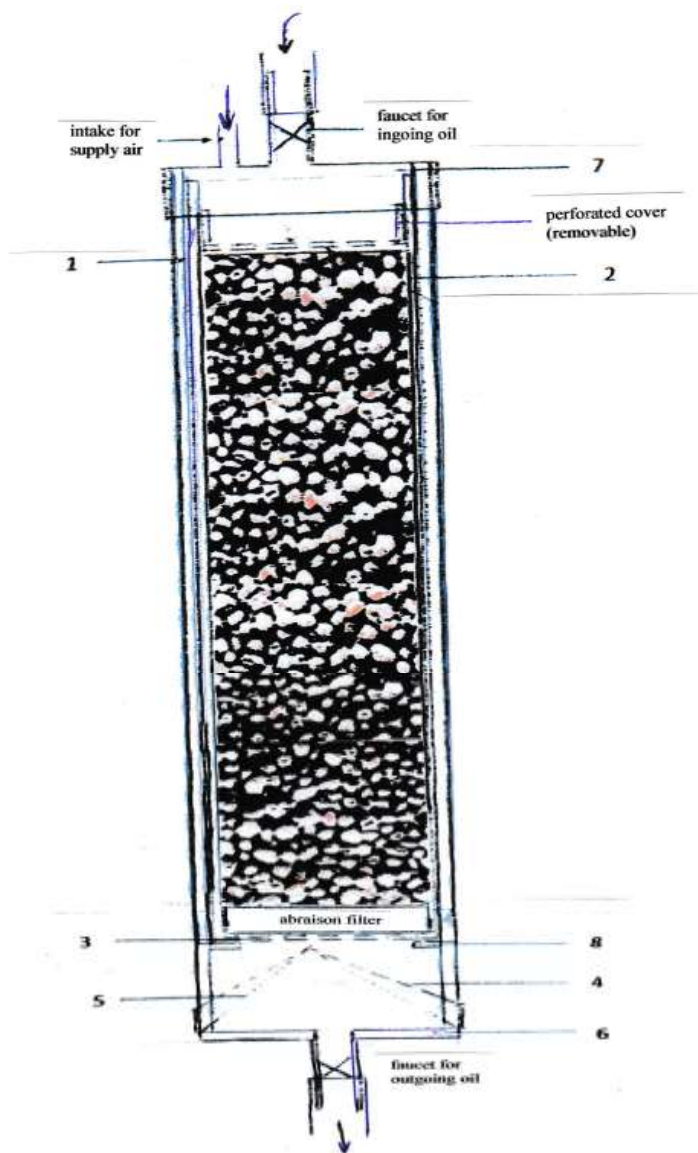
oil-water-mixture started to seep into the bed of expanded clay. The uncoated clay globules had a specific function: they were used to keep gaps open for the oil-water-mixture to seep through the bed. Without them, it might happen that the swelling of the polysaccharide coat of the coated clay globules closes these gaps, and the oil-water-mixture would no longer find a way through. Note: the whole process of this experiment does not use any pumping; it is caused by gravity. The result of this experimental approach could be observed in the sampling beaker: the oil was no longer turbid, it did not contain emulsified water. A control experiment with uncoated clay globules did show that the oil that had passed the cartouche did still contain substantial turbidity; it was not free of water. The explanation for the effect is that only part of the water had been removed from the oil-water-mixture. This was caused by the fact that only small volumes of water were taken up into the globules by the kapillar absorbency of the clay globules due to the presence of narrow pores and small cavities inside the globules that are inherent in expanded clay globules.

3. Results and Conclusions

As a result of the laboratory experiment, a device was designed that should, if put into effect, be a solution for the problem of removal of water from mineral oil, at least regarding low volumes of oil.

An advantage of such a device is that it does not need supply of energy; hence, it could even have a layout as a mobile apparatus. One more advantage would be the low costs of material (expanded clay, polysaccharide) when an exchange of the cartouche is needed due to exhaustion of the water binding capacity of the polysaccharide in the cartouche. A disadvantage is that a layout as depicted in Figure 1 would not be feasible for larger volumes of oil. However, this design may be the basis for future developments that make use of the principle as such.

Figure-1.



Legend to Figure 1

Design of a proposed device for removal of water emulsified in mineral oil

- 1 Casing
- 2 Cartouche with expanded clay globules („Exclay“) coated with polysaccharide, and with uncoated exclay globules. Cartouche removable for exchange

- 3 Perforated bottom of the cartouche
- 4 Coarse filter
- 5 Fine filter
- 6 Filter casing with outlet (removable for cleaning of the filters)
- 7 Upper cover of the casing with faucet for inlet (removable)
- 8 Mechanical stopper for the cartouche

The intake for supply air is needed to avoid a vacuum otherwise caused by lowering of the level of the oil. The oil would be hindered in its flow downwards.

The cartouche can easily be removed (upward) for exchange

The perforated cover (removable) has the function to distribute the incoming oil over the entire surface of the bed of exlay particles

The perforated bottom of the cartouche allows the oil to leave the cartouche

There are two filter systems: the abraison filter collects flake-like polysaccharide debris that occasionally occurs, and fine mineral particles occasionally occurring due to abraison of the clay globules; it has a sponge-like appearance and is made from plastic. The second filter system can replace the abraison filter: the coarse filter collects the polysaccharide debris, the fine filter collects the fine mineral particles. The abraison filter is a component of the cartouche, the second filter system is a component of the casing. The abraison filter is replaced by a new one when the cartouche is refilled. The casing of the second filter system is removable for cleaning of the two filters.

It would be of advantage when ready-to-go replacement cartouches are in stock.

In fact, this device is a metallic construction set which can be stripped down for cleaning of its components.

References

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