

Solvent-free Deoiling of Paraffin

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Paraffin waxes are recovered from the residues of lubricating oil production. Sulzer Chemtech has developed a new process, which is characterized by its low consumption of energy, high yield and complete freedom from solvents and thus contributes to the protection of the environment. The process is employed in the world's largest static crystallization plant belonging to Schümann Sasol in Hamburg.

Waxes have been used in many different ways since the early days of mankind – the best known is probably Daedulus who, according to Greek mythology, made wings of wax and feathers for himself and his son Icarus to escape from Crete. They utilized one of the characteristics of wax, which is now an important constituent of hot-melt adhesives. At the moment, the manufacture of candles (Fig. 1[■]) is the most important and frequent application of waxes. In the meantime, they have become indispensable for the manufacture of many other products.

- For the protection of rubber articles (e.g. tires and cables) against premature aging through ozonization
- For the manufacture and impregnation of paper and cardboard
- As a constituent of numerous cosmetics (e.g. skin-cream, lipsticks and vaseline)

- As a corrosion preventative or inhibitor (water repellent)

Wax is a collective name for a series of natural or artificial recovered substances. The former common definition (ester of long-chain carboxylic acids with long-chain alcohols) was extended, because the physical and technical characteristics of a substance are now the deciding factors for the assignment (e.g. viscosity, fusibility and flammability). The crystalline waxes with a paraffin base recovered from crude oil are now the most important. They result from the production of lubricating oil, where they are looked upon as an unwanted contaminant. Regarded by the refineries as a waste product, the so-called slack waxes find ready acceptance in the wax industry. To meet a continuously increasing demand, they are used to produce more than 3 million tons/year high-quality waxes throughout the world.

[■] *The manufacture of candles is the most important application of paraffin. The purity and hardness of the paraffin determine the processing mode and subsequent flammability.*

WHY DEOILING?

Waxes with a paraffin base have to fulfil extremely stringent requirements. For example, the highly automated candle industry insists on a constant product quality. The slack waxes (Fig. 2[■]) have to be purified for the manufacture of odor-free and drop-free candles. Depending on their origin, they can contain up to 20% oil-like, respectively low-melting components, which are removed by means of a deoiling process. In general, a maximum oil content of 0.5 to 1.5 wt.% is required for the finished product. The solidification temperature and the hardness of the wax, which is indicated by the needle penetration value, are further quality characteristics.

FLEXIBLE PRODUCTION, HIGH YIELD

Depending on the crude oil and the processing mode, the refineries supply slack waxes with very different compositions. Flexibility for the very different raw material characteristics is the fundamental requirement for modern processes. A high yield is a further condition. The demand for lubricating oil is stagnating in Western Europe and North America, because modern engines do not need so much oil and, at the same time, the proportion of synthetic lubricating oil is increasing. In view of this, slack waxes are only available in limited quantities, and so the growing demand can only be met by increasing the yield.

Two fundamentally different forms

of deoiling are known and used for the production of high-quality paraffin: the old sweating method and the new, more efficient process of deoiling with a solvent. The problems that arise with all solvent processes are attributable to the environmentally hazardous and unhealthy properties of the organic, frequently chlorinated, solvents that are used in large quantities, and also their corrosivity and high inflammability. In addition, the recovery of the solvent and the required cooling increase the energy consumption.



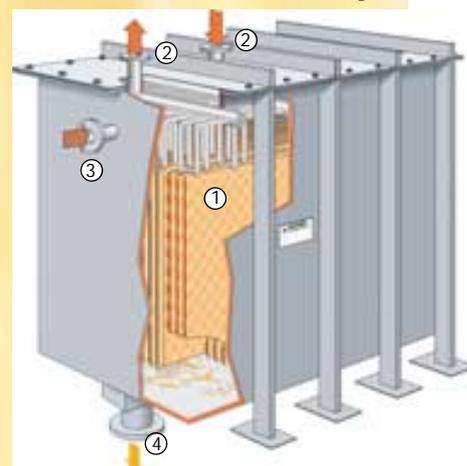
2[■] The basic substance for the recovery of paraffin, so-called slack wax, is a waste product of lubricating oil production and obtained in different compositions.

Deoiling by means of sweating was the only known, large-scale, technically applied process for the deoiling of slack waxes. Admittedly, this process is ecologically harmless and cost-effective, but the yields and flexibility are insufficient.

SPARING THE ENVIRONMENT AND THE PURSE

The construction of new chemical plants requires the provision of an environment-friendly process and assured viability. The crystallization processes from Sulzer Chemtech prove that these two requirements can be brought to a common denominator. They enable organic substances to be purified without any solvents. Furthermore, they are also characterized by their low energy requirement, high reliability and a wide field of application.

The deoiling of paraffins on the basis of static crystallization is a successful and simple process which, thanks to modern crystallizers and concepts, is now being employed on an increasing scale. With static crystallizers, the crystals grow on cooling elements, which immerse in the melts. Exact temperature control is a decisive factor for crystal growth and thus for the purification. The contaminants concentrate in the remaining melts, which are drained off at the end of crystallization. After this, the crystal layer is sweated to separate off any adhering contaminants. Finally, the crystal layer is melted off to provide the liquid product.



Static crystallizer with cooling and heating elements (1), on which the crystals grow: heat carrier (2), feed stock (3), product/residue (4). The crystallizer is located in the heating phase, in which the temperature is increased to melt the crystal layer.

3 ■ A section of the plant during the erection stage. The various crystallizers are served by a fully automatic process-control system.



STRUCTURE PAVES THE WAY TO SUCCESS

These negative aspects obviously fostered a call for the development of a new deoiling process for slack waxes, which would have to fulfil the following criteria:

- Solvent-free deoiling
- Increased yield compared with existing processes
- High flexibility with regard to the changing characteristics of the raw material and the end product
- Low production costs and thus high profitability

The first tests conducted with various slack waxes in standard crystallizers from Sulzer Chemtech revealed the limits of the existing processes. Although it was possible

to meet the expectations with regard to product quality by means of multi-staging, i.e. repeated crystallization, the goals that were set for the yield could not be realized with the existing equipment. The reprocessing of the residues by means of further crystallization, which was practiced with other products, also failed. This was due

to the excessive oil content of the solidified products that caused the crystal mass to prematurely slide off the heat exchanger plates and into the crystallizer during sweating, and thus impaired good separation.

The sliding of the crystal layer called for a supporting or holding structure, which would facilitate the exchange of heat and the run-off of the expelled oil on the one hand, but would retain the paraffin on the other. Following in-depth investigations with various elements, a perforated plate structure proved to be most suitable in practice. This was the key to success (see box "Sparing the environment and the purse").

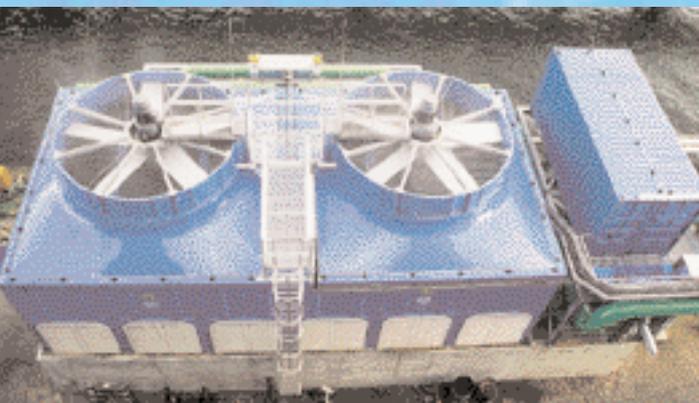
The function of the structure may be described as follows: The crystal layer is supported partly by guiding elements, which are inclined towards the heat exchanger plates. This results in an enlargement of the surface and enables the crystal layer to be routed to the surface of the heat exchanger by means of a slide on the deflector. At the same time, the expelled components resulting from the heating of the

RECOOLING SYSTEM REALIZED IN A SHORT TIME

The cooling water of the Sulzer Chemtec crystallization plant for Schümann Sasol has to be re-cooled; this task is fulfilled by a plant from Sulzer Industriekälte. The total heat-transmission capacity is about 11 MW, whereby approximately 1400 m³/h has to be cooled from 33 °C to 25 °C.

The scope of supply provided for a complete plant with steel structure, cooling tower and consumer pumps, internal pipework, electric switchgear with the electrical installation and

the lightning protection equipment. The water treatment unit and the electric switchgear are accommodated in a container, which is installed at a height of about 6 metres (picture: right). The plant was commissioned on schedule in mid-August 1998, just six months after the order was placed, and has been operating trouble-free ever since.



crystal layer are led off in a downward direction by way of special guideways. For this, the guiding element is provided with a perforation through which the liquid fractions with their oil-content can drip.

The conversion of the test apparatus into an industrial plant resulted in further customer requirements which had to be fulfilled and were new for static crystallization plants:

- Simultaneous deoiling of diverse slack waxes
- Faster product change and thus high flexibility
- Guaranteed annual capacity of 100 000 tons
- Monitoring of the complete plant by only one employee

A new process and automation concept was elaborated for the fulfillment of these tasks. In this case, the crystallizers were divided into part systems (Fig. 3[■]) and connected to a joint heating and cooling system. An intermediate tank farm permits a quick change between various products and thus a start-up without any loss of production. A discharge sequence, which is operated fully automatically by the process-control system, was developed for the synchronization of the crystallizers.

[■] 100 000 tons of slack wax are deoiled annually at the world's largest static crystallization plant belonging to Schümann Sasol in Hamburg.

FIRST PLANT IN OPERATION

This new process was realized through the close cooperation of Sulzer Chemtech and Schümann Sasol, the world's leading supplier of natural and artificial waxes. This company commissioned the first deoiling plant successfully in Hamburg in 1998 (Fig. 4[■]).

Sulzer Chemtech provided the basic engineering and 20 crystallizers. 100 000 tons of slack wax are deoiled annually at this static crystallization plant, which is the largest in the world. It replaces two old plants, in which chlorinated solvents were employed. In comparison with existing plants, the yield is 10 to 30% higher, and the specific consumption of energy has been reduced by up to 30%. Thanks to the automation of the process,

the expenditure on personnel is low. The hitherto high costs for the procurement, processing and disposal of the solvent can now be saved. All in all, this results in high economic efficiency. Ω

FOR MORE DETAILS

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