Process of oxidation of bitumen

Bitumen is a hydrocarbon product which is received as the distillation bottom product of an oil refining process and has a high boiling point and viscosity and is soluble in trichloroethylene. Also the soluble binder product separated from natural asphalts by extraction is bitumen. To improve the properties of bitumen it can be oxidated to be suitable for intended applications. This oxidation can be carried out by leading air to the bitumen which is oxidated by the effect of the oxygen diffused into the oil phase from the air.

In modern preparation methods of oxidated (blown or semi-blown) bitumen qualities the air needed for the oxidation and the bitumen oil is brought into contact in a large volumed reactor (so-called bubble column technique). The drawbacks of the method are the safety risks because of the large oil and gas volume, the high oxygen content of the rest gas, a bad adjustability of the reaction and the reduced quality properties of the product because of the long retention time.

The contact between the bitumen and the oxygen has been improved by using a turbine mixer in the oxidation of the bitumen. This turbine mixer comprises a mixer foreseen with an impeller that consists of a cogged face plate. The use of such a mixer does not, however, essentially improve the transfer of the material.

It is also mentioned as prior art which is concerned with a method of oxidation of bitumen by air in a large volume reactor. The aim of this invention is to reduce the retention time of the oxidation reaction and thus avoid reducing of the quality properties. The cold properties are even improved. The aim is e.g. to achieve a bitumen product suitable to be used as road coating expressly in cold conditions, as in the Northern countries, which for instance means that no fractures are allowed to be formed into the coating.

The method of the invention is mainly characterized in that the oxidation is carried out by leading a supply stream of bitumen or the like and an air stream or another pressurized gaseous oxidant to a reactor which is a so-called rotating apparatus and in which reactor the contact between the air or other gaseous oxidant and the bitumen or the like is improved by generating turbulence by mixing devices of rotor-stator type that generate shear forces to achieve a good mixing. "

The advantageous embodiments of the invention have the characteristics of the subclaims.

The contact between the air and the bitumen is carried out in the invention by using high turbulence. The reactor used in the invention generates turbulence by using mixing devices of rotor-stator type that generate the shear forces: the bitumen and the air are forced through the reactor in such a way that

strong shear forces and much mixing is directed to those with a good dispersion of the air as a result that is very advantageous for the contact. In the preparation method of the invention, the reactor used to improve the contact of the air-bitumen mixture, the so-called rotating apparatus, is a so-called power homogenizer, which is a mixing device of the type wherein the mixing is achieved ▪ by one or more rotor-stator pairs, alone or in series.

It has been shown by tests in Bench scale that by the method of the invention the retention time needed can be reduced to a submultiple of the actual one. A shorter retention time and a better contact means an essentially smaller investment in oil or gas and thus a diminishing of the safety risks and less use of air.

By the invention the bitumen and the air react considerably faster than with the actual bubble column technique, wherein mixing is not used and also faster than by means of conventional mixing devices. The total rate of the reactions is the essential factor. Coarsely, the rate of the reactions depends on two factors:

- the rate of the transfer of the oxygen from air to the bitumen - the rate of the reactions between oxygen and the bitumen.

The transfer of the materials can be further improved by influencing on the following things:

- the conditions in the reactor

- the construction of the reactor

- the amount of the reactors (different reactor couplings).

In the oxidation reactor the oxygen of the air and the bitumen react so that the oxygen molecule cleaves a part off from the long chained molecule thus forming short chained hydro peroxides and on the other hand long chained compounds containing oxygen. These long chained molecules containing oxygen tend to combine thus forming still more long chained molecules.

The rate of the transfer of the materials can in other words be influenced on by the construction of the reactor, in other words by selection of dimensions and amounts of rotor-stator pairs and by selecting the dimensions of the reactor. In other words the existing turbulence in the reactor can very much be influenced on by the inner construction of the reactor. Different cogs, guiding means for streams, pump effects and other things are factors by means of which the function of the reactor can be designed in the wished way.

The conditions in the reactor

A raising of the temperature in the reactor increases the diffusion coefficient and thus also the conversion coefficient. A suitable temperature in the invention is 180-240° C, but 150-300° C is a possible working range.

An increased amount of air accelerates the oxidation of the bitumen as then there is more oxygen in the reactor for a given amount of bitumen, whereat the amount of oxygen diffused into the bitumen is bigger. A suitable volume ratio liquid/air is 2/1 -1/50 when the reactor is pressurized.

An elevated of the pressure increases the amount of air in the reactor as air is an comprimable gas. The total time of the reactions will then be reduced and higher amounts of bitumen can be processed with the same device. The volume of the bitumen does not essentially change as an effect of the pressure. The inner overpressure of the power homogenizer to be used in the invention is as high as possible e.g. >. 6 bar, preferably j> 20 bar. The mechanical strength of the apparatus sets a limit for the overpressure. The small apparatus of the invention has lead to that use of high overpressures is possible and more safe.

The distribution of the retention time of the product and thus the product properties can be influenced on with an inner circulation in the apparatus, wherein the return is carried out from the outside of the reactor back to the inside. The curing of the product can be increased with circulation.

Also the material transfer in the reactor increases with an increasing turbulence. A suitable circumferential speed of the rotor is appr. 1-100 m/s.

The reactor can either be coupled so that the supply will come to the outer periphery of the reactor or to the middle of the periphery (peripheries) of the reactor. The turbulence in the reactor can be increased by supplying the bitumen and the air to the periphery of the reactor. If the air and the bitumen are fed to the middle of the periphery (peripheries) of the reactor, the need of pumping and comprimation energy is less. Also the apparatus costs are then lower.

The amount of the reactors

It is possible to couple the oxidation reactors of the bitumen in several manners. Several reactors can e.g. be coupled in series and/or in parallel. It is also possible to couple reactors with the supplies to the middle of the periphery (peripheries) and to the outer periphery in different ways to each other. The best embodiment is the so-called "once through drive" wherein the bitumen and the air are flowing only once through the reactor system.

In another embodiment, both the bitumen and the air (rest air or fresh air) are pressurized (pumped/comprimated) and further are fed to the following reactor. Then it is question about series connection of two or more reactors.

Yet in another embodiment there are used a reactor of mixing container type that works continuously or batch wise. The advantages of the invention in production scale

The advantages of the invention in production scale have been evaluated in the following.

Safety

- in possible leakage situations the bitumen volume is considerably smaller as the pumping of the bitumen to the homogenizer can be interrupted at once and the bitumen content of the homogenizer is considerably smaller than that of a conventional blowing reactor. Also the gas volume is considerably smaller of this reason which means a smaller explosion and fire risk

- furthermore, thanks to this, there is a smaller amount to be safety blown; a simpler and more reliable safety blowing system. - as the reactions are more effective, the oxygen content is considerably lower than in the oxidation air exhaust gases which improves the fire safety.