impurities present in the recycled alkanesulfonic acid the catalytic activity, and thus the conversion in the chemical process employing alkanesulfonic acid as catalyst, declines.

The reactivity of the alkanesulfonic acid in distillation processes also needs to be taken into account. Alkanesulfonic acids can react with organic substances, for example olefins or aromatics, in manifold ways. Depending on the reaction conditions and the type of the organic reactants this can form decomposition products of alkanesulfonic acid, for example the methyl ester of methanesulfonic acid, sulfur dioxide or H_2S. Takeuchi et al., J. of the Japan Petroleum Institute, Vol. 50(4), 2007, pages 88-194 describes the formation of oligomers of volatile olefins with methanesulfonic acid. With less volatile aromatic olefins, which are also present in the process for producing linear alkylbenzenes (LAB process), a reaction of the methanesulfonic acid with the olefins to form dark products in the distillation bottoms is observed. Above 150°C and at longer reaction times as are typical in continuous chemical production methods, even high-viscosity, tar-like products are formed. The reaction is promoted by the use of a high temperature and a low concentration of water. However, these are precisely the conditions found in a distillative purification operation for alkanesulfonic acid. For example, achieving sufficient catalytic activity of the methanesulfonic acid requires a water content of less than 1 wt%. In order to be able to achieve this concentration by distillation, at moderate subatmospheric pressures of about 0.1 bar (abs) temperatures of about 190°C are required. These conditions in the bottoms of a distillation result in massive formation of dark high boilers which render impracticable a solitary distillation process step for purification of methanesulfonic acid in a method that recycles methanesulfonic acid. Distillation of the methanesulfonic acid overhead requires yet higher temperatures and/or requires low pressures which entail great cost and complexity. While such a distillation regime affords pure methanesulfonic acid at the top of a distillation column, it is very energy-intensive, results in yield losses and leaves behind highly impurified, high-boiling olefins in the bottoms of the distillation.

The present disclosure accordingly has for its object the provision of a method of reprocessing alkanesulfonic acid employed in a chemical process as an agent, catalyst or solvent which may be carried out with relatively low capital expenditure and relatively low energy use.

The object is achieved, in an aspect, by a method of reprocessing alkanesulfonic acid employed in a chemical process as an agent, catalyst or solvent and comprising the steps of:

(a) removing an alkanesulfonic acid-comprising stream from a reaction mixture generated in the chemical process,

(b) feeding the alkanesulfonic acid-comprising stream into a melt crystallization as the starting melt to form crystals of the alkanesulfonic acid, of hydrates of the alkanesulfonic acid or of a mixture of both suspended in mother liquor,

(c) performing a solid-liquid separation to remove the crystals from the mother liquor,

(d) optionally washing the crystals to remove mother liquor adhering to the crystals,

(e) recycling the washed or unwashed crystals removed from the mother liquor into the chemical process.

It has now been found that, surprisingly, the melt crystallization makes it possible to remove impurities from the alkanesulfonic acid in amounts sufficient to allow said acid to be reused in the chemical process without an appreciable decline in conversion in the chemical process while additionally reducing the necessary energy requirement compared to the prior art method of purifying the alkanesulfonic acid.

Impurities are generally present in the form of low boilers or high boilers. The term "low boilers" is to be understood as meaning water and all components having a boiling point below the boiling point of alkanesulfonic acid. The term "high boilers" is to be understood as meaning all components having a boiling point above the boiling point of alkanesulfonic acid. The alkanesulfonic acid is in particular methanesulfonic acid.

Another advantage is that, in contrast to hitherto employed methods of distillative purification of alkanesulfonic acid, the method as defined above makes it possible to achieve high purities in simple fashion in particular in the purification of methanesulfonic acid. The method as defined above moreover removes the majority of high boilers from the alkanesulfonic acid which is achieved in the prior art only through energy intensive distillation by converting the alkanesulfonic acid into the gas phase. However, this conversion of the alkanesulfonic acid, in particular methanesulfonic acid, has the further disadvantage that said acid is highly corrosive under the conditions in the gaseous distillation thus necessitating the use of complex, corrosion-resistant apparatuses.

In order to be able to recover the alkanesulfonic acid, it is necessary in a first step to initially remove said acid from the reaction mixture generated in the chemical process. To this end it is possible, for example, to add water, the alkanesulfonic acid being transferred into the aqueous phase in this case. Alternatively, many applications, for example the production of linear alkylbenzenes, in which the alkanesulfonic acid is used as catalyst in any case generate a biphasic reaction mixture having a hydrophilic phase and a hydrophobic phase. In these cases in which the reaction mixture is biphasic or a second phase is generated by addition of water, the alkanesulfonic acid-comprising stream is preferably removed from the reaction mixture by phase separation. This may be achieved using any apparatuses for phase separation known to those skilled in the art. Alternative methods are, for example, extractive or chromatographic methods. However, these have the disadvantage of low selectivity or are very costly and complex.

The crystallization causes the impurities to be removed from the alkanesulfonic acid and to accumulate in the mother liquor. However, since the mother liquor still comprises a large proportion of uncrystallized alkanesulfonic acid it is preferable when the mother liquor after removal of