As the most important of the short chain alkanesulfonic acids is methanesulfonic acid, the description in the following often refers to methanesulfonic acid in an exemplary manner. The inventive improved process as described herein can, however, also be applied to the manufacture of higher alkanesulfonic acids, the alkyl group having 1 to 4 C-atoms, as well.

This disclosure relates to an improved process for the continuous production of methanesulfonic acid by the reaction of sulfur trioxide and methane with the help of a peroxide initiator, which is prepared with an aqueous hydrogen peroxide solution. The process is characterized in that a high MSA-yield referring to SO3 is achieved and the amount of waste is reduced. The inventive procedure is based on dividing the addition of the initiator on several reactors of a cascade of reactors. If this had no impact on the reaction one could expect e.g. the same yield and the same amount of material to be purged from the system being formed. It has been shown that dividing the addition of the starter into several portions surprisingly has a beneficial effect on the process as e.g. the yield increases and the amount of material to be purged from the system decreases.

An object of the present disclosure is a process for the production of alkane sulfonic acid by the reaction of sulfur trioxide and alkane with the help of a starter and/or starter precursor, wherein the addition of the starter and/or starter precursor to the reactor or the reactor cascade is split.

In the context of the inventive process, “split” means to divide the addition of the overall starter amount over several addition points in the system, rather than stopping and restarting the addition of starter limited to one single addition point, e.g. one reactor.

Another object of the present disclosure is a process for the production of alkane sulfonic acid by the reaction of sulfur trioxide and alkane with the help of a starter, selected from the group consisting of inorganic peroxoacids, salts of inorganic peroxoacids, organic peroxoacids, salts of organic peroxoacids, hydrogen peroxide and mixtures thereof, and/or starter precursor, selected from the group consisting of sulfuric acid, oleum, SO3, alkanesulfonic acid, the bottom recycle stream from alkanesulfonic acid distillation, inorganic oxoacids, salts of inorganic oxoacids, hydrogen peroxide and mixtures thereof, wherein the addition of the starter and/or starter precursor to the reactor or the reactor cascade is split, wherein the synthesis is realized as batch process in a reactor cascade and the starter or starter precursor is divided.

The addition of the overall starter amount is realized over several addition points in the system, e.g. addition over several addition points to the first reactor and to further reactors of the cascade, **or** wherein the synthesis is realized as continuous process and the starter or starter pre-

cursor is divided and the addition of the overall starter amount is realized continuously over several addition points in the system to the first reactor and to further reactors of the cascade.

In one aspect of the present disclosure, there is provided a process for the production of alkane sulfonic acid by the reaction of sulfur trioxide and alkane with the help of a starter, selected from the group consisting of inorganic peroxoacids, salts of inorganic peroxoacids, organic peroxoacids, salts of organic peroxoacids, hydrogen peroxide, and mixtures thereof, and/or starter precursor, selected from the group consisting of sulfuric acid, oleum, SO3, alkanesulfonic acid, the bottom recycle stream from alkanesulfonic acid distillation, inorganic oxoacids, salts of inorganic oxoacids, hydrogen peroxide, and mixtures thereof, wherein the addition of the starter and/or starter precursor to the reactor cascade is split, wherein the synthesis is realized as batch process in a reactor cascade and the starter or starter precursor is divided and added in portions to the first reactor and to further reactors of the cascade, **or** wherein the synthesis is realized as continuous process and the starter or starter precursor is divided and added continuously to the first reactor and to further reactors of the cascade.

Another object of the present disclosure is also an alkane sulfonic acid, preferably methanesulfonic acid, obtainable by the inventive process.

Figure 1 shows one example how a process for the production of MSA by reaction of methane and sulfur trioxide can be set up and will be explained below in an exemplary manner.
Figure 2 shows an exemplary reactor set up for an embodiment of the inventive process.

A **Reaction:** Methanesulfonic acid (MSA) is formed from methane and SO_3 with a mixture of MSA and sulfuric acid as a solvent.

$$SO_3 + CH_4 \rightarrow CH_3\text{-}SO_3H \qquad -134\ kJ/mol \qquad \textit{1}$$

The reaction usually takes place at pressures from 10 to 200 bar and temperatures ranging from 25 to 100 °C. In a preferred mode, the pressure is between 30 to 150 bar, more preferred between 50 and 110 bar, most preferred between 70 and 100 bar. In a preferred mode of operation, the temperature is between 40 to 80°C, more preferred between 45°C and 65°C. The reaction is triggered with the help of an initiator (also called starter in the following), which is formed with the help of a peroxide, e.g. hydrogen peroxide. For the formation of the starter, hydrogen peroxide can be directly dosed into the reactor. In another option, the starter can be synthesized in a separate unit. In

another embodiment, it is preferred to form the starter by reaction of the recycle stream and hydrogen peroxide as described below in step D→A.

The raw materials methane, SO3 and H2O2, and the solvent containing sulfuric acid and/or MSA are typically provided in the feed in a molar ratio of methane/SO3 between 0.50 to 2.0 mol/mol, preferred between 0.75 to 1.2 mol/mol. The ratio of H2O2/SO3 is typically in the range between 0.001 to 0.20 mol/mol, preferred between 0.01 to 0.10. The molar ratio between SO3 and MSA in the feed to the reactor system is typically set between 0.1 to 100 mol/mol, preferred 1 to 80 mol/mol, more preferred between 5.0 to 65.0 mol/mol. In a normal and stable mode of operation these ratios are kept constant by adequately dosing fresh feed components. The absolute amount of SO3 in the feed stream is between 20% and 85 wt%, preferably 40% to 75 wt%, more preferably between 60 and 75 wt%.