[0008] There remains, therefore, a need for a simple, efficient, economical and industrially cost-effective industrial process for the preparation of alkanesulphonic acid and methanesulphonic acid in particular.

[0009] Patent applications US2006100458 and US2005070614 describe the preparation of methanesulphonic acid (CH_3SO_3H) from methane (CH_4) and sulphur trioxide (SO_3). The reactions described in these two documents, however, are all performed in batch mode in autoclaves, often small sizes, in an inert atmosphere, for example under nitrogen. The autoclaves are heated, for example up to about 80 °C, with methane pressures ranging from 2 MPa (300 psi) to almost 10 MPa (1400 psi). It is obvious that such reaction conditions, in the presence of such synthetic reagents, render said process for the preparation of methanesulphonic acid from methane and sulphur trioxide, not feasible industrially.

[0010] However, it could be very interesting to convert methane, a natural gas, into methanesulphonic acid (AMS) in the presence of sulphur trioxide (SO_3).

[0011] It has now been found that it is possible to convert an alkane to the corresponding alkanesulphonic acid, for example methane to methanesulphonic acid, in the presence of sulphur trioxide, in a continuous process, in a simple, effective way with good yields. Furthermore, the process of the ~~invention~~disclosure can very easily be operated on an industrial scale. The process of the ~~invention~~ disclosure also facilitates alkanesulphonic acid purity levels greater than 95%, or even greater than 98%.

[0012] Other advantages of the present disclosure~~invention~~ will be highlighted in the following description.

[0013] Thus, according to a first ~~aspect~~example, the present disclosure~~invention~~ relates to a process for the continuous industrial preparation of an alkane-sulphonic acid, from the corresponding alkane and of sulphur trioxide, said process being carried out in a solvent which is the said alkanesulphonic acid.

[0013a] In an aspect, there is provided a process for the continuous industrial preparation of alkanesulphonic acid of formula $C_nH_{2n+1}SO_3H$ from the alkane of formula C_nH_{2n+2}, wherein n represents an integer comprised between 1 and 20 inclusive, preferably between 1 and 12 inclusive, more preferably between 1 and 6 inclusive, and for example equal to 1, 2 or 3, said process comprising at least the following steps:

a) loading of alkanesulphonic acid $C_nH_{2n+1}SO_3H$, wherein n is as defined above, in a reactor,

b) heating said alkanesulphonic acid at a temperature comprised between 25 °C and 120 °C, preferably comprised between 25 °C and 100 °C, more preferably comprised between 25 °C and 70 °C,

c) introducing a quantity of sulphur trioxide so that the molar ratio (alkanesulphonic acid)/(sulphur trioxide) is comprised between 70/30 and 95/5,

d) introducing the alkane under a pressure comprised between 4 MPa and 15 MPa, preferably comprised between 5 MPa and 12 MPa,

d) introducing a radical initiator,

e) continuous conducting of the reaction, simultaneously, sequentially or alternatively performing the following three sub-steps e1), e2) and e3):

e1) addition of sulphur trioxide in order to maintain the initial molar ratio (alkanesulphonic acid)/(sulphur trioxide) defined in step c),

e2) addition of alkane in order to maintain a molar ratio (alkane)/(sulphur trioxide) comprised between 4/1 and 2/1, preferably between 3.5/1 and 2.5/1, typically so as to maintain a molar ratio (alkane)/(sulphur trioxide) equal to about 3, and

e3) continuous withdrawal of the alkanesulphonic acid of formula $C_nH_{2n+1}SO_3H$, and

f) recovery of the alkanesulphonic acid of formula $C_nH_{2n+1}SO_3H$ after optional separation of unreacted reagents, and optionally any undesired by-products.

[0013b] In another aspect, there is provided a reaction medium comprising an alkane sulphonic acid of formula $C_nH_{2n+1}SO_3H$, wherein n is an integer comprised between 1 and 20 inclusive, preferably between 1 and 12 inclusive, more preferably between 1 and 6 inclusive, and for example equal to 1, 2 or 3, sulphur trioxide SO_3, and an alkane of formula C_nH_{2n+2}, wherein n is as previously defined, said reaction medium, in which:

the molar ratio (alkanesulphonic acid)/(SO_3) is comprised between 70/30 and 95/5, and

- the molar ratio (alkane)/(SO_3) is comprised between 4/1 and 2/1, preferably between 3.5/1 and 2.5/1, typically equal to about 3.

[0014] "Corresponding alkane" refers to the alkane comprising the same number of carbon atoms as the alkanesulphonic acid which is to be continuously manufactured industrially. As non-exhaustive list of examples, methane (CH_4) is used to prepare methanesulphonic acid (CH_3SO_3H), ethane (C_2H_6) is used to prepare ethanesulphonic acid ($C_2H_5SO_3H$), propane (C_3H_8) is used to prepare propanesulphonic acid ($C_3H_7SO_3H$), butane (C_4H_{10}) is used to prepare butanesulphonic acid ($C_3H_7SO_3H$), etc., and more generally the alkane from formula C_nH_{2n+2} is used to prepare the alkanesulphonic acid of formula ($C_nH_{2n+1}SO_3H$).