nitrogen, carbon dioxide and small amounts of steam. Compared to the processes using steam as the main source of inert gas, as described above, this process has the advantage that much smaller amounts of liquid wastewater are produced, but the disadvantage of a greater offgas stream, which likewise includes organic sulphur compounds. The amount of the offgas stream is also much higher compared to the standard acrolein process. Furthermore, since there is no recycling of propylene to the reaction step, this ~~invention~~ disclosure ~~discloses~~has a lower propylene utilization and hence a smaller amount of acrolein (or MMP) produced per molar unit of hydrocarbon supplied compared to the standard acrolein process.

It was therefore an **object** of the ~~present invention~~embodiments disclosed herein to provide an integrated process for preparing acrolein by catalytic gas phase oxidation of propylene with oxygenous gas and further reaction of the acrolein produced with methyl mercaptan to give MMP, which has the disadvantages of the known processes only to a reduced degree, if at all.

More particularly, the process according to the ~~invention~~disclosure should work in a very energy-efficient manner with maximum acrolein and MMP yields, i.e. should have minimum energy and steam consumption and minimum waste streams, but at the same time ensure preparation of acrolein in maximum yield based on the amounts of propylene used and, as a result, of MMP of maximum purity and in maximum yield.

This object is **achieved** in accordance with the ~~invention~~ disclosure by a process for preparing MMP from acrolein and methyl mercaptan according to process option 1, in which the following steps are performed successively:

A) gas phase oxidation of propylene with the aid of air over a heterogeneous catalyst in the presence of a diluent gas

B) collecting the acrolein-containing gas stream from A) in a quench stage for removal of by-products, for example acrylic acid, acetic acid, formaldehyde or conversion products thereof

C) recovering the residual acrolein fractions from the liquid present in the lower part of the quench stage B) by stripping, especially from a liquid stream drawn therefrom,

D) (after dividing the acrolein-containing gas stream into at least two streams) collecting a first portion of the acrolein-containing gas stream from the quench

E) stage B) in an absorption stage in the presence of water to obtain an aqueous acrolein solution

D1) at least partly recycling the uncondensable gas from D) as dilution or inertization gas into reaction stage A)

F) distillatively removing the acrolein from the aqueous acrolein solution from D) in a distillation stage

E1) condensing the acrolein-containing distillate from E) and supplying the distillate to a reaction stage F)

and feeding a further portion of the acrolein-containing gas stream from the quench stage B) directly into the reaction stage F) for reaction with methyl mercaptan in the presence of MMP and/or MMP/MC hemithioacetal.

In a first aspect, there is provided a process for preparing 3-methylmercaptopropionaldehyde from acrolein and methyl mercaptan, in which the following steps are performed successively:

A) gas phase oxidation of propylene with the aid of air over a heterogeneous catalyst in the presence of a diluent gas

B) collecting the acrolein-containing gas stream from A) in a quench stage for removal of by-products

C) recovering the residual acrolein fractions from the liquid present in the lower part of the quench stage B) by stripping

D) collecting a first portion of the acrolein-containing gas stream from the quench stage B) in an absorption stage in the presence of water to obtain an aqueous acrolein solution

D1) at least partly recycling the uncondensable gas from D) as diluent gas into reaction stage A)

E) distillatively removing the acrolein from the aqueous acrolein solution from D) in a distillation stage

E1) condensing the acrolein-containing distillate from E) and supplying the distillate to a reaction stage F)

and feeding a further portion of the acrolein-containing gas stream from the quench stage B) directly into the reaction stage F) for reaction with methyl mercaptan in the presence of 3-methylmercaptopropionaldehyde and/or 3-methylmercaptopropionaldehyde/methyl mercaptan hemithioacetal.

Such a process (configuration B/process option 1) has the particular advantage over the conventional standard processes (configuration A) that it enables, with about the same acrolein yields and about the same amount of offgases, a somewhat smaller amount of waste water with a simultaneous distinct decrease in the consumption of demineralized water and a distinct reduction in steam consumption and in cooling energy in the form of cooling tower water or cooled water (Table 1). In addition, the storage of liquid acrolein is avoided, which offers a considerable advantage with regard to lower capital costs and avoidance of hazardous substance storage.

Compared to DE102010064250.9, this disclosure~~invention~~ additionally ~~has~~ discloses the advantage of higher acrolein yields with low cooling tower water consumption and much smaller amounts of offgas and correspondingly much lower offgas treatment costs. More particularly, it is advantageous that the process ~~according to the invention~~as defined above enables production and utilization of an internal dilution or inertization gas stream from absorption stage D, and thus minimization of the consumption of additional inertization gas such as nitrogen, steam or other inert gases, for example methane, natural gas or propane. Inert gases in this context are gases which do not react over the catalyst under the customary production conditions.

According to the ~~invention~~disclosure, the abovementioned object is also **achieved** by a process for preparing MMP from acrolein and methyl mercaptan according to process option 2, in which the following steps are performed successively:

A) gas phase oxidation of propylene with the aid of air over a heterogeneous catalyst in the presence of a diluent gas in a first reaction unit and

A1) simultaneous gas phase oxidation of propylene with the aid of air over a heterogeneous catalyst in the presence of a diluent gas in a further reaction unit

B) collecting the acrolein-containing gas stream from A) in a quench stage with cooling for removal of by-products, for example acrylic acid, acetic acid, formaldehyde or conversion products thereof,

B1) collecting the acrolein-containing gas stream from A1) in a parallel quench stage for corresponding removal of by-products,

C) recovering the residual acrolein fractions from the liquid present in the lower part of the quench stage B) by stripping, especially from a liquid stream withdrawn therefrom,

D) collecting at least a portion of the acrolein-containing gas stream from the quench stage B) in an absorption stage in the presence of water to obtain an aqueous acrolein solution

D1) at least partly recycling the uncondensable gas from D), which also contains as yet unconverted propylene into reaction stages A) and A1) as a diluent or inertization gas

E) distillatively removing the acrolein from the aqueous acrolein solution from D) in a distillation stage

E1) condensing the acrolein-containing distillate from E) and supplying the distillate to a reaction stage F)

and feeding the acrolein-containing gas stream from the quench stage B1) directly into the reaction stage F) for reaction with methyl mercaptan in the presence of MMP and/or MMP/MC hemithioacetal.

In a second aspect, there is provided a process for preparing 3-methylmercapto-propionaldehyde from acrolein and methyl mercaptan, in which the following steps are performed successively

A) gas phase oxidation of propylene with the aid of air over a heterogeneous catalyst in the presence of a diluent gas in a first reaction unit and

A1) simultaneous gas phase oxidation of propylene with the aid of air over a heterogeneous catalyst in the presence of a diluent gas in a further reaction unit

B) collecting the acrolein-containing gas stream from A) in a quench stage with cooling for removal of by-products

B1) collecting the acrolein-containing gas stream from A1) in a parallel quench stage for removal of high boilers

C) recovering the residual acrolein fractions from the liquid present in the lower part of the quench stage B) by stripping

D) collecting at least a portion of the acrolein-containing gas stream from the quench stage B) in an absorption stage in the presence of water to obtain an aqueous acrolein solution

D1) at least partly recycling the uncondensable gas from D) as diluent gas into reaction stages A) and A1)

E) distillatively removing the acrolein from the aqueous acrolein solution from D) in a distillation stage

E1) condensing the acrolein-containing distillate from E) and supplying the distillate to a reaction stage F)

and feeding the acrolein-containing gas stream from the quench stage B1) directly into the reaction stage F) for reaction with methyl mercaptan in the presence of 3-methylmercaptopropionaldehyde and/or 3-methylmercaptopropionaldehyde/methyl mercaptan hemithioacetal.

Such a process (according to configuration C/process option 2) has the particular advantage over the conventional standard processes (configuration A), analogously to process option 1, that it enables, with about the same acrolein yields and about the same amount of offgases, a somewhat smaller amount of wastewater with a simultaneous distinct decrease in the consumption of demineralized water and a distinct reduction in steam consumption and in cooling energy in the form of cooled water (Table 1). Equally, the storage of liquid acrolein is avoided, which offers a