

# ALIEN PROPERTY CUSTODIAN

## PROCESS FOR CHEMICAL REACTIONS IN MELTS

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Object of our invention is a process for carry-  
ing out chemical reactions consisting in introduc-  
ing gaseous or vaporous reactants into a melt.  
This melt serves as a heat carrier, acting itself  
catalytically or containing catalysts. The intro-  
duction of the reactants into the melt is carried  
through in such a manner that the gases or vapors  
effect a permanent, thorough and uniform in-  
termixture of the melt as well as of the intro-  
duced substances. The temperature in the melt  
is well adjusted according to the conditions of the  
reaction. By these means it is possible to main-  
tain the melt during the whole process at the de-  
sired temperature which proves to be of special  
advantage for the reaction. At the same time  
it is possible to bring the reactants into intimate  
contact with each other and also with the melt  
and the catalysts. In consequence of the consid-  
erable capacity of heat of the salt melt with re-  
spect to the comparatively insignificant little  
parts of the reaction participants which are pres-  
ent in the melt, all possible chemical reactions  
may be carried through isothermically, even if the  
reactions per se are qualified by marked absorp-  
tion or evolution of heat. As a consequence of  
the permanent intermixture of the melt, evolved  
by the gaseous or vaporous reactants, new heat  
transfer as well as catalytically effective contact  
surfaces between the melt and the reactants are  
constantly formed.

The introduction of the gaseous and/or vaporous  
reactants into the melt may be carried out  
with nozzles or the like. If necessary, the agi-  
tating effect may be enhanced by the introduc-  
tion of a gaseous initial substance in excess or  
even in great excess. According to our invention  
it is also possible to introduce inert gases or va-  
pors, as for instance, carbonic acid, water vapor  
and the like, besides the other gaseous or vaporous  
reactants, in order to increase the agitation in  
the melt.

Our invention is especially suitable for the  
carrying through of various reactions, such as  
for instance, the chemical addition of water,  
splitting off water, hydrogenation, dehydrogena-  
tion, oxidation, dissociation, polymerisation and  
the like. At the same time organic compounds  
of different character, for example hydrocarbons,  
compounds containing oxygen, such as alcohols,  
aldehydes, carboxylic acids, ketones, phenols,  
amines and the like may be introduced into the  
melt and brought to conversion therein. Fur-  
thermore, reactions of an anorganic nature, for  
instance, the manufacture of hydrocyanic acid  
ex carbon monoxide and ammonia, or the manu-  
facture of SO<sub>2</sub> and the like may be carried out  
according to our invention.

Thorough investigations have shown that a  
considerable amount of substances may be used  
for the manufacture of the aforementioned melts,

such as for instance, nitrates, nitrites, chromates,  
acetates, chlorides, cyanides, bromides, further-  
more oxides, hydroxides, sulfates etc. of alkali  
metals, earth alkali metals, earth metals, rare  
earths, such as cerit chloride and so on. Further-  
more carbonates, phosphates, borates, silicates,  
such as glasses or silica, and the like, cyanates,  
urea or other organic substances such as higher  
boiling or high melting hydrocarbons, for instance,  
paraffin, naphthalene, dekahydronaphthalene,  
halogenated naphthalene, diphenyloxide, nitro-  
benzene or the like may be used as initial sub-  
stances for the bath.

The above mentioned compounds and sub-  
stances may be used sometimes per se but usual-  
ly we have found it advantageous to combine some  
of these compounds to form a mixture which is  
especially suitable for the necessary temperatures  
as well as for the desired reaction. Generally,  
the composition of the melt will be selected in  
such a manner that the temperature of the re-  
action will be counterbalanced between the solidi-  
fication point and the evaporation point.

### EXAMPLES

#### I. NITRATES

	Degrees Centigrade
30 KNO <sub>3</sub> + 70 LiNO <sub>3</sub> -----	130
55 KNO <sub>3</sub> + 45 NaNO <sub>3</sub> -----	218
50 KNO <sub>3</sub> + 50 NaNO <sub>3</sub> -----	140
50 NaNO <sub>3</sub> + 50 NaNO <sub>2</sub> -----	220

#### II. CHLORIDES

(a)

	Degrees Centigrade
31 BaCl <sub>2</sub> + 48 CaCl <sub>2</sub> + 21 NaCl-----	430
50 BaCl <sub>2</sub> + 30 KCl + 20 NaCl-----	540

(b) Chlorides + carbonates

50 KCl + 50 Na <sub>2</sub> CO <sub>3</sub> -----	560
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(c) Chlorides + fluorides

85 CaCl <sub>2</sub> + 15 CaF <sub>2</sub> -----	645
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(d) Chlorides + sulfates

35 NaCl + 65 Na <sub>2</sub> SO <sub>4</sub> -----	620
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(e) Chlorides + phosphates

35 K <sub>3</sub> PO <sub>4</sub> + 67 KCl-----	720
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(f) Chlorides + borates

88 BaCl <sub>2</sub> + 7 Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub> + 5 MgO-----	980
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(g) Chlorides + carbonates + sulfates

40 NaCl + 20 Na <sub>2</sub> CO <sub>3</sub> + 40 Na <sub>2</sub> SO <sub>4</sub> -----	500
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#### III. CHROMATES

50 K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> + 50 Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> -----	300
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IV. SULFATES	
25 $K_2SO_4 + 75 Na_2SO_4$ -----	830
V. PHOSPHATES	
70 $Na_4P_2O_7 + 30 K_4P_2O_7$ -----	875
44 $K_4P_2O_7 + 56 KPO_4$ -----	615
VI. SILICATES	
45 $BaSiO_3 + 55 Na_2SiO_3$ -----	905
VII. BORATES	
50 $NaBO_2 + 50 LiBO_2$ -----	648
VIII. BROMIDES	
50 $KBr + 50 NaBr$ -----	640

The regulation and maintainance of the suitable temperature of the reaction may be carried into effect by external heating, but we prefer mostly to use internal heating. If the reactions are of an exothermic nature the liberated heat may be used for internal heating, for instance in such a manner that the conversion is combined with an other exothermic reaction or combustion. We have found it advantageous to use flues or dipping burners for internal heating, whereby the dipping burners may be arranged in a chamber adjacent to the reaction chamber in such a way that no mixture of the combustion gases with the reaction products takes place. The heating may also be effected by means of an electric current, for instance, by resistance heating or by heating through electrodes whereby the salt melt acts as an electrolyte and the alternative current may be conducted through electrodes in contact with the electrolytes. Furthermore, we have found it useful, to combine various heating means, for instance in such a manner that the main heat supply will be effected by means of dipping burners or flues whereas the fine adjustment will be carried out by resistance or electrode heating. Moreover, the use of internal heating has the advantage that the walls of the melting vessel may be made out of metallic as well as out of ceramic material and hence be adapted perfectly to the thermic and chemical stress.

If the heating is carried out with electrodes the latter may either act chemically or catalytically or influence the conversion in a favorable manner. We have found it advantageous to use graphite electrodes with the manufacture of hydrocyanic acid ex carbon monoxide and ammonia, whereby the electrodes may deliver the carbon as well as remove the undesired oxygen.

By carrying out our invention we proceed sometimes in such a way that the substances to be introduced into the melt are subjected to a pre-heating and may then be used for internal heating or adjustment of temperature. The pre-heating of the substances to be introduced may be effected with the waste heat, for instance, coming from the flues. Excessive introduction of reaction participants or additional introduction of inert gases or vaporous substances will also lead to the formation of excessive heat.

Furthermore, the introduction of gaseous or vaporous substances into the melt may be used

to blow liquid or finely divided solid substances into the melt.

As we have already mentioned, the melts may be used or their composition selected in such a manner that they may act specifically or catalytically per se. Certain oxidising reactions may be improved by introducing of boric acid or borates or barium compounds into the melt. On the other hand, specifically acting catalysts, insoluble in the melt, may be used either alone or in combination, for instance, in such a manner that they are suspended in the melt in a finely or extremely finely powdered condition. Catalysts which tend to deposit in the melt or to rise therein, may be precipitated on suitable carriers which do not liquefy and may be suspended in the melt.

As catalysts various elements and compounds such as for instance, metals, metal compounds, earth acids or salts may be used. For instance, hydrogenations may be carried into effect with the aid of the usual hydrogenation catalysts, such as nickel, iron, molybdenum, tungsten, zinc oxide. Oxidations may be carried into effect in the presence of oxidation catalysts, such as for instance, iron oxide, vanadic acid and so on; splitting off water will be carried out in the presence of aluminium oxide, titan dioxide, earth alkali phosphates and so on. Carriers for catalysts, which themselves tend to deposit, are aluminium oxide, voluminous or active silica, asbestos, magnesium oxide, beryllium oxide, charcoal, activated charcoal; carriers for ascending catalysts are, for instance, heavy metals, such as tungsten, copper and the like.

Our invention has been proved especially suitable for the carrying through of reactions which require high temperatures as well as for the maintainance of a constant temperature, such as for instance, the manufacture of acetylene or ethylene from methane. Furthermore, our invention is extraordinarily well suited for the carrying out of partial oxidation reactions as for instance, the manufacture of phthalic acid or maleinic acid by oxidation of aromatic hydrocarbons; or, for the manufacture of carboxylic acids, ketones, aldehydes or alcohols by partial oxidation of methane or its homologues.

Our invention may be carried out at usual pressure, under vacuo or at increased pressure, also at high and very high pressure. If it occurs that considerable quantities of the melt are carried over in a vapor- or mist like form together with the reaction products, these quantities may be collected in an absorption bulb and re-conducted into the melting vessel. The melts as well as the catalysts therein may be regenerated during the operation, for instance, in such a manner that one part of the melt will be passed over into a chamber adjacent to the reaction chamber, where it will be subjected to a regenerating treatment, for instance, by means of water vapor or oxidising gases and afterwards re-conducted into the reaction vessel.

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