

pressure, injection wells increase, application of the conformance control,) liquidation of cross flows behind the casing and production casing leaks. The approved oil recovery can be achieved by large volumes of produced water.

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SYNTHESIS OF ZEOLITE MATERIALS USING A TWO-STEPS METHOD AND STUDY OF ITS PROPERTIES FOR FURTHER USE IN FLUID CATALYTIC CRACKING (FCC)

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Zeolites are porous aluminosilicates materials that have valuable properties for industry, being used mainly in adsorption and catalysis. The synthesis of zeolites is performed using sources of aluminum (Al) and silicon (Si) in contact with a strong base, sodium hydroxide (NaOH), for example. The reaction extracts the Si and Al minerals from the solution and a reorganization of the atoms, with the presence of sodium cations (Na⁺) occurs. The composition of the materials present in the zeolite can be expressed as the following expression [1-3, 5]:



Where,

- M is an interchangeable cation or valence compensation cation n;
- m is the number of water molecules;
- x and y are the number of tetrahedra per unit cell of the corresponding oxide;
- x / y = Si / Al ratio, which can vary from 1 to infinity (Loewenstein's rule - which explains that the crystalline network cannot contain the type of Al-O-Al bonds) [2,4,6,8].

As can be seen, the Si/Al ratio is one of the most important parameters in the synthesis, since each zeolite has a specific range for its formation to be possible [3, 5, 7].

Currently, many materials become wastes and increase environmental problems. Some have a high concentration of Si and Al, and could be used in zeolite synthesis, for example. Among them, some that are valuable sources of minerals are ashes originated from combustion processes for power generation - rice husk and coal fly ashes [2,4].

Composed by 47 % to 65 % SiO₂ and 16 % to 29 % Al₂O₃ of mass, the coal fly ash is largely employed in the synthesis. In addition, the use of rice husk is possible, since they are composed primarily of silicon oxide (SiO₂), with more than 90%. Moreover, different materials that have high concentration of Si and Al, can also be used as raw materials for the synthesis [2, 6, 9].

Furthermore, it is also very important that the materials contain a small concentration of iron (Fe₂O₃) and calcium (CaO). In the synthesis reaction, if these two components are present in high quantities, the reaction between NaOH and Si and Al, will not be preferable. Since competitive reactions occur. Thus, turning impossible the synthesis of specific zeolites, as zeolite Y, to occur [4-6, 10].

Therefore, with the results obtained from x-ray fluorescence analysis data, it was possible to determine the main types of materials with quantified compositions of oxides that could be employed in the zeolite synthesis. The selected materials are Tomsk clay, rice husk ash, oat husk ash, Kuzbass, Seversk and Tomsk coal fly ashes [4, 7-10].

Once the zeolite is obtained, it is possible to transform it in a catalyst. Nowadays the most prominent zeolite is zeolite Y, because of the porosity and cationic exchange capacity. The materials listed above provide all the requirements for the zeolite two-step synthesis method. [3, 5, 7]

Mainly, zeolites can be synthesized from raw materials in two different process: one-step and two steps. The main difference between the methods is the intensity of the interaction between the ash and the base. Thus, the two-steps method is the first method with an addition of the hydrothermal fusion process, where ashes are fused with NaOH, for improvement of the interaction of the cations, and extraction of Si and Al from the ash into the system. [2-4, 8-10]

Moreover, within the optimization of the zeolite synthesis process in a two-steps method is possible to achieve higher specific surface area, and exchange capacities [1, 4, 9]. Furthermore, the main zeolite, as previously informed, used in the catalysis is the Zeolite Y; and the most available zeolites in the market use a variation of the zeolite Y, with different materials as for catalyst support. Therefore, following the synthesis and optimization of the zeolite two-steps method, the production of highly promising zeolites to be used as catalysts is enhanced [2, 9].

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GAS HYDRATE FORMATION AND ITS PREVENTION IN GAS-FIELD OPERATIONS

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Gas hydrate formation is the one of negative factors in gas production. It reduces service operating life of the gas-gathering main and decreases its capacity; hydrate formation complicates or makes refining process impossible, decreases efficiency of gas transportation, and leads to emergencies in the field facilities. All these necessitate studying the mechanism of gas hydrate formation and choosing methods for its prevention and elimination.

Factors affecting formation time of gas hydrate formation rate and molecular dimension dependence on the gas hydrate structure

Three conditions are obligatory for gas hydrate formation in the pipelines: certain temperature and pressure, an agent which can create a hydrate structure and enough amount of water. Growth rate of gas hydrate formation depends on some factors shown in Figure 1 (a).

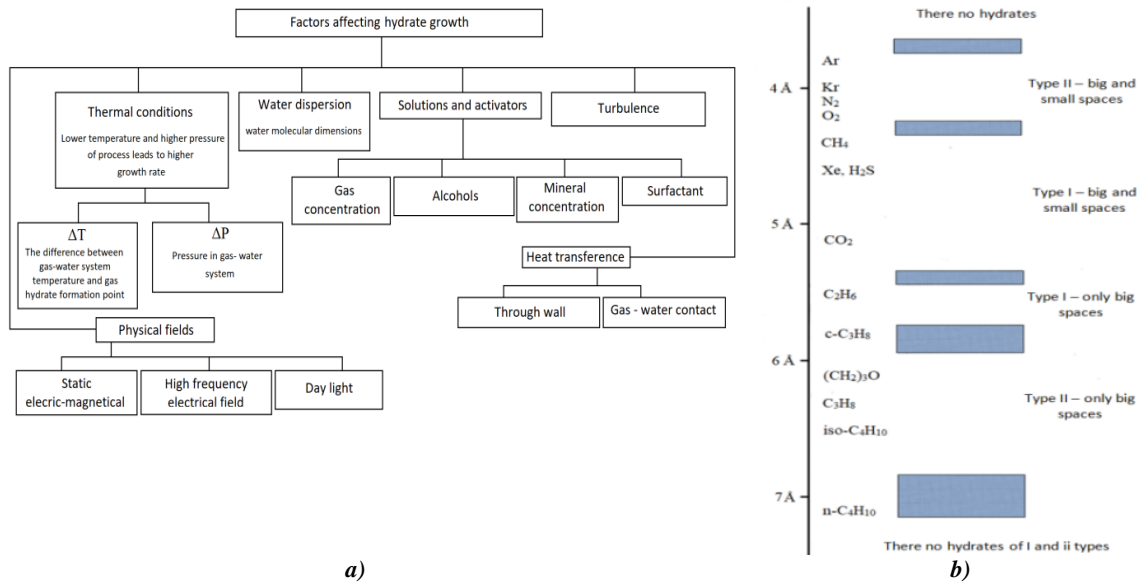


Fig. 1 The classification of main factors affecting hydrate growth rate of natural and oil gas (a) and molecular dimensions dependence on the gas hydrate type $1 \text{ \AA} = 10^{-10} \text{ m}$ (b)

Scheme in Figure 1 (b) shows the dependence between molecular dimensions and hydrate structures. According to this scheme, a molecule having a diameter more than 3.8 \AA (hydrogen, helium) and less than 7 \AA (C₅, C₆ and more) can't form any gas hydrate structure. The main components of natural gas (methane, ethane) form the hydrate structure I.

Calculations of gas hydrate formation probability and estimates of temperature and pressure distribution

We can use the formula (1) for determining possible hydrate formation in some sections of pipelines and gas hydrate formation point of hydrate development.

$$\Delta = \mu_w^\alpha - \mu_w^H = \mu_w^{\beta-H} - \mu_w^{\beta-\alpha} = \ln a_w - R_\mu T \left(\sum_{i=1}^2 v_i \ln(1 - \sum_{j=1}^C \theta_{ij}) - \frac{\Delta \mu_w^0}{R_\mu T_0} + \int_{T_0}^T \frac{\Delta H_w}{R_\mu T^2} dT - \int_0^p \frac{\Delta V_w}{R_\mu T} dp \right) \quad (1)$$