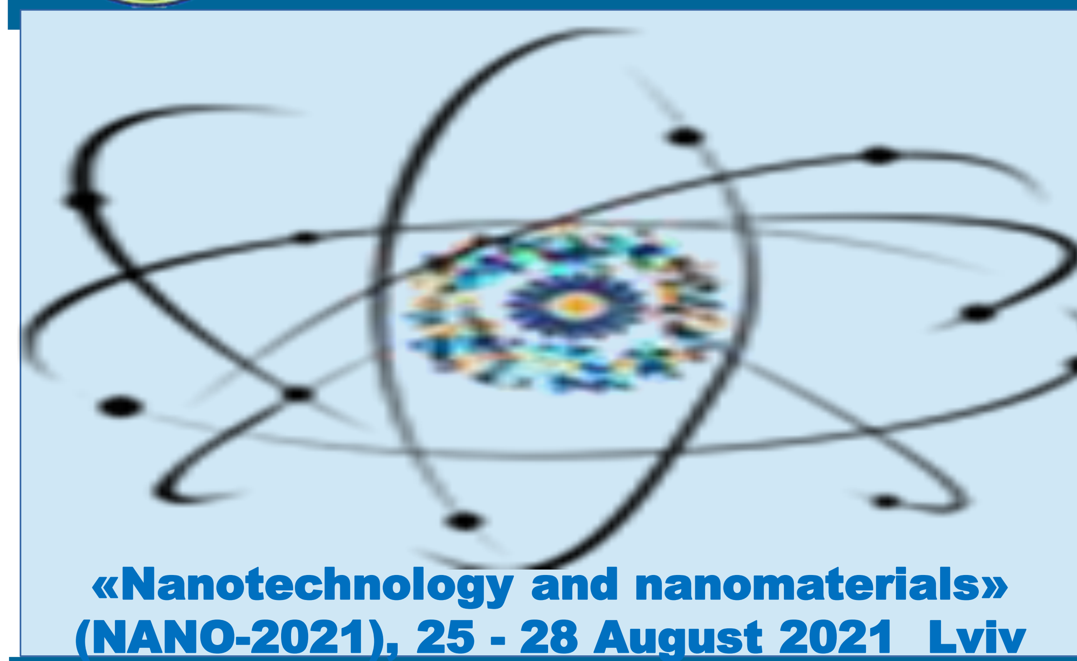
Porous surface structure and physicochemical properties of urea-formaldehyde foam



ANDRIY NEMISH - Member of the circle Ivano-Frankivsk Academy of Sciences "Theoretical and Experimental Chemistry", CNTTUM, Department of Chemistry of Vasyl Stefanyk Precarpathian National University Ivano-Frankivsk; narwest2004@gmail.com

SERGIY KURTA- Professor of the Chemistry Department Vasyl Stefanyk Precarpathian National University ", Ivano-Frankivsk. Ukraine.
https://kc.pnu.edu.ua; sergiykurta@pnu.edu.ua

Abstract

Thermal insulation micro structured foams based on various polymers have been widely used in various industries for thermal insulation of buildings and walls. However, raw materials for the production of most of them are quite expensive and toxic . In this regard, the urgent problem is the production of foams based on cheap and technological polymers, which are urea-formaldehyde resins (UFR) which have reduced toxicity. Urea-formaldehyde foams of the UFR type occupy a special place among gas-filled plastics for thermal and sound insulation. The inability of UFR to self-combustion, and to stop combustion after removal of the flame source and the inability to melt the UFR polymer during combustion indicates a high fire safety of urea foam compared to polystyrene and polyurethane foam.

Metodologic and results

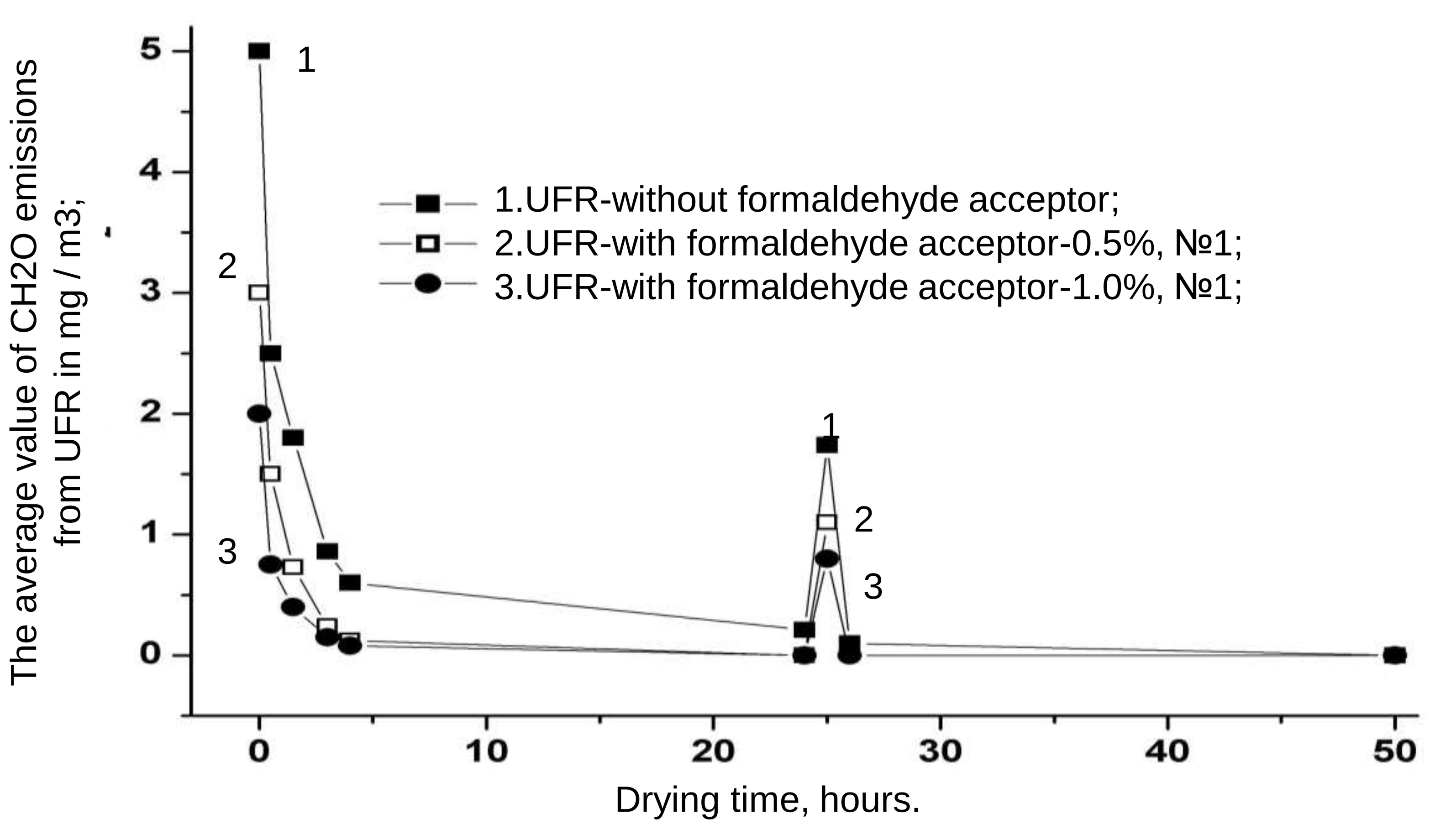
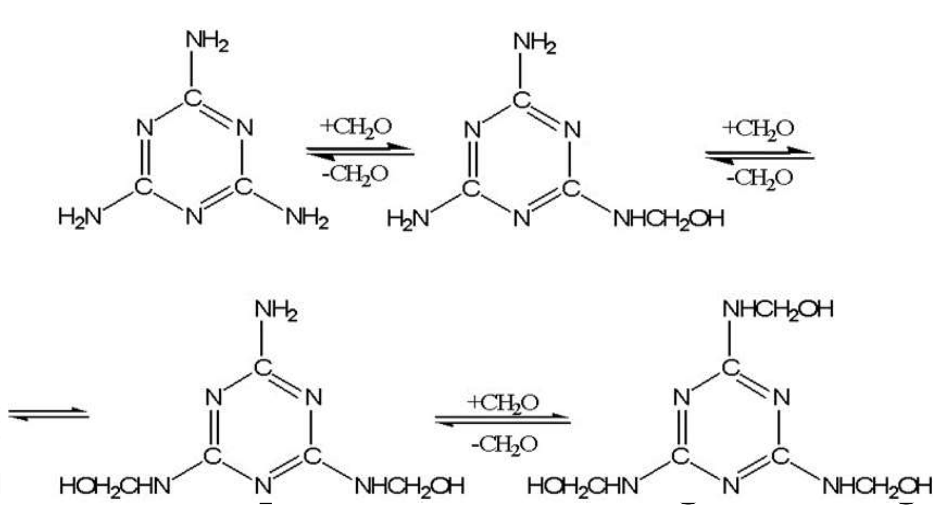


Fig.1. Graphic dependence of gaseous formaldehyde emission, after preparation and drying of urea-formaldehyde foam (at 20 ° C, 24 h), without and with the addition of formaldehyde acceptor in different quantities.

A positive result was obtained due to the introduction of special chemical acceptors of formaldehyde and chemical foaming agents. This led to a 2-3-fold reduction in the emission and concentration of free formaldehyde from urea-formaldehyde foam and a reduction in its volume shrinkage, and a decrease in water and moisture absorption of UFR. New chemical formaldehyde acceptors have been proposed that can rapidly and efficiently interact with free and bound formaldehyde in urea-formaldehyde foams during manufacture and operation.

Chemical reactions of acceptors - neutralization of formaldehyde

1. $H_2NCONH_2 + CH_2O \longrightarrow H_2NCONHCH_2OH$
2. $H_2NCONHCH_2OH + CH_2O \longrightarrow HOCH_2NHCONHCH_2OH$
3. $(NH_4)_2CO_3 + H_2O \rightarrow H_2CO_3 + NH_4OH$
4. $H_2CO_3 \rightarrow H_2O + CO_2\uparrow$
5. $4NH_4OH + 6CH_2O \rightarrow (N)_4(CH_2)_6 + 10H_2O$
6. $NH_4Cl + CH_2O \rightarrow CH_3NH_2xHCl + HCOOH$
7. $CH_3NH_2xHCl + 2CH_2O \rightarrow (CH_3)_3 NH_2xHCl + 2HCOOH$



A new method for determining the emission of gaseous has been developed, which is based on of the MIS-98 component of the developed installatthe use ion. Due t foamers, the linear and volume shrinkage of UFR was reduced by 3-4 times, to the above values.

Their main advantages are good thermophysical characteristics, but low manufacturability and high flammability of polystyrene foam and polyurethane foam. Urea-formaldehyde foams are almost as good as polystyrene and polyurethane foam in terms of industrial production of thermal insulation. But UFRs have a number of disadvantages, namely, emit large amounts of toxic formaldehyde in their manufacture and molding. In addition, UFRs have a large shrinkage after curing, which reduces by 15-20% the linear and volumetric dimensions of the foam after curing.

Industrial brands UFR have high water and moisture absorption, which leads to a deterioration of the thermal insulation properties of urea-formaldehyde foam, so they must be protected during long-term operation. Therefore, in this work, an attempt was made to reduce the emission of free formaldehyde from UFR through the introduction of chemical formaldehyde acceptors in UFR composite polymer mixture for foaming. Additionally, the linear shrinkage was reduced to 3-5%, and the water and moisture absorption of foamed UFR was reduced to a minimum.

A positive result was obtained due to the introduction of special chemical acceptors of formaldehyde and chemical foaming agents. This led to a 2-3-fold reduction in the emission and concentration of free formaldehyde from urea-formaldehyde foam and a reduction in its volume shrinkage, and a decrease in water and moisture absorption of UFR. New chemical formaldehyde acceptors have been proposed that can rapidly and efficiently interact with free and bound formaldehyde in urea-formaldehyde foams during manufacture and operation. A new method for determining the emission of gaseous formaldehyde from urea-formaldehyde foams has been developed, which is based on the use of the MIS-98170 formaldehyde gas analyzer as the main component of the developed installation. Due to the use of special new chemical gas-forming foamers, the linear and volume shrinkage of UFR was reduced by 3-4 times, to the above values.

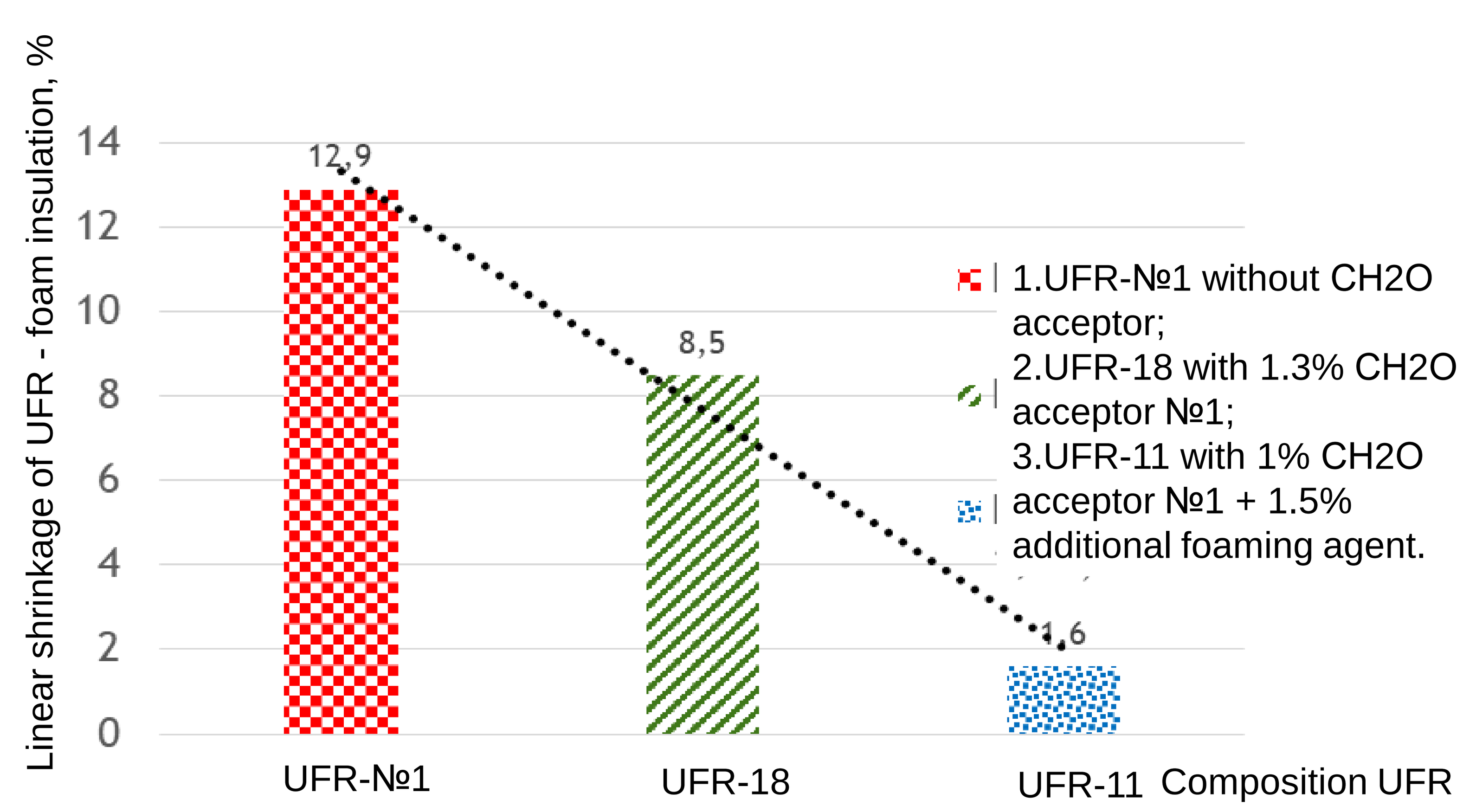


Fig. 2. Dependence of linear shrinkage of industrial foam insulation after production and drying 48 hours, (1-foam insulation without additives KFP-1; 2-foam insulation with the addition of formaldehyde acceptor KFP-18; 3-foam insulation with foamers and acceptor KFP-11.

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