

## Whitepaper

# The influence of insulation blowing agents on pipe corrosion

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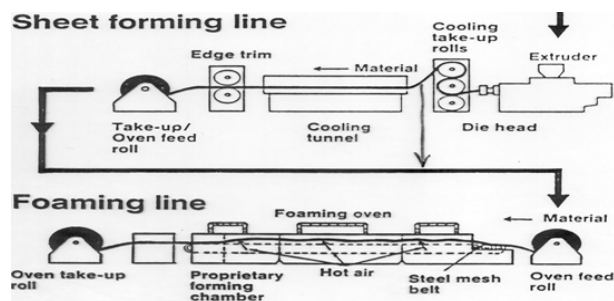
**One of the most important applications of synthetic foams relates to thermal insulation. To minimize loss in the transport, distribution and storage of heat and cold, but also to prevent condensation. For thermal applications, rigid foams such as polyurethane, semi-rigid foams such as polystyrene or polypropylene, as well as flexible foams such as polyethylene or rubber elastomers have been developed.**

It is also known that cross-linked polymers and elastomers are hardly recyclable in contrast to physically foamed thermoplastic polymers. The latter are fully recyclable and therefore have much less environmental impact. Commonly used chemical blowing agents also contain an ODP (Ozone Depletion Potential) from 0 to a minor GWP (Global Warming Potential).

**In the world of synthetic insulation, 2 main types of blowing agents are used to foam the product: chemical and physical blowing agents.**

### Chemical blowing agents

With chemical blowing agents, the use of Azodicarbonamide ( $C_2H_4N_4O_2$ ) – a scentless, yellow to orange crystalline powder - is commonplace. This material is used as the main blowing or foam agent for the production of expanded thermoplastic polymers, cross-linked polymers and elastomers. The nitrogen that's released when the Azodicarbonamide (ADC) is heated up, resulting in the cell formation within the polymer matrix thus creating a foam.



**Fig. 1 Schematic illustration of chemically blown sheet, in which a solid is produced first, which is then foamed by the reaction of the ADC when heated.**



**Fig. 2 The same happens with circular produced elastomers.**

In 2004, the European Commission prohibited the use of the substance as a blowing agent for polymers that come into direct contact with food. (**DIRECTIVE 2004/1/EG 6/1/ 2004-** <http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1467874172105&uri=CELEX:32004L0001> ) That's because when heated, Azodicarbonamide can partly decompose into a semicarbazide, which in animal tests has shown to be a weak carcinogen.

### Stress crack corrosion:

The chemical reaction between components of the ADC chemical blowing agent and the metal pipe can result in a stress crack corrosion. The corrosion reaction is activated by water vapor diffusion or water absorption of the insulation material.

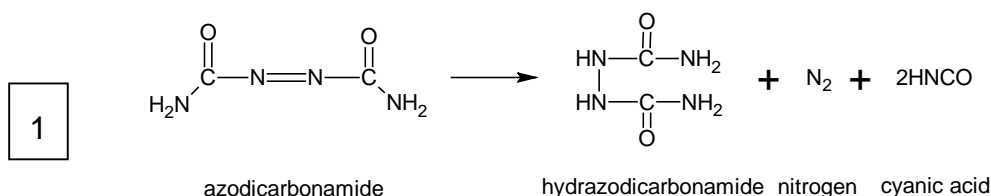
#### In detail:

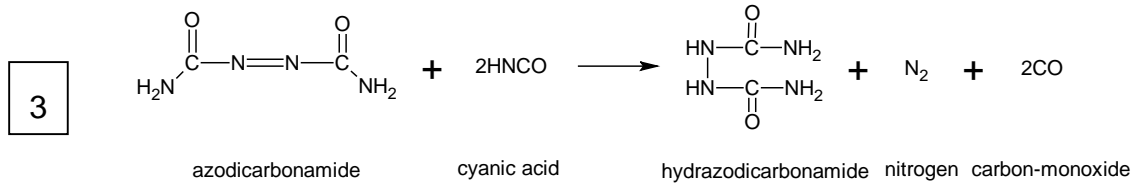
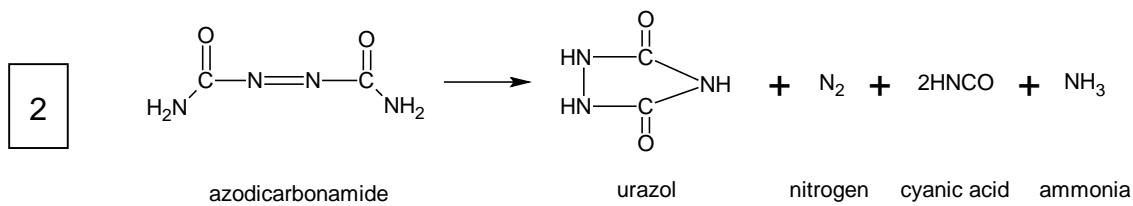
Elastomer insulation is usually foamed with ADC. The ADC is heated up during the production process, thereby releasing 3 main gasses; nitrogen, carbon monoxide and ammonia (figure 3). As these gasses form the cell structure and remain inside the product for a certain period, this can create problems. When water enters in or under the insulation, a chemical reaction with ammonia will take place (figure 4).

Possible reasons for water entering in or under the insulation could be:

- Insufficient, or poorly installed insulation
- Damaging of vapor-tight outer layer
- $\mu$ -value too low
- Lower insulation thickness by 'stretching' in turns or fittings, by which the vapor point is displaced outside the insulation

### Kinetic Study of the Decompositions Involved in the Thermal Degradation of Commercial Azodicarbonamide





### Figure 3: decomposition reactions of ADC.

The ammonia released in reaction 2 during the decomposition of ADC, can lead to the reactions below, causing stress crack corrosion.

Ammonia and water form Ammonium ( $\text{NH}_4^+$ ) and Hydroxide ( $\text{OH}^-$ ). These molecules, in combination with copper (messing = Cu Zn Fe) cause the Cu to be formed into  $\text{Cu}(\text{OH})_2$  and  $\text{Cu}(\text{NH}_3)_4^{2+}$  (as shown in reactions below).

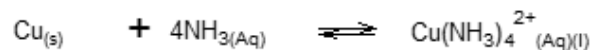
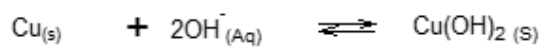
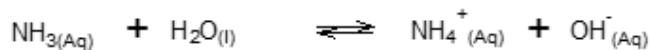
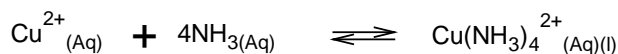
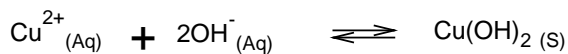
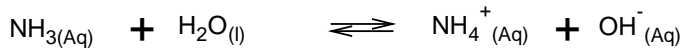


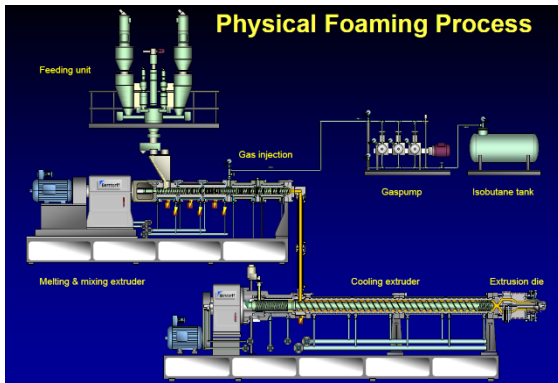
Fig.4: reaction of ammonia with water leading to stress crack corrosion



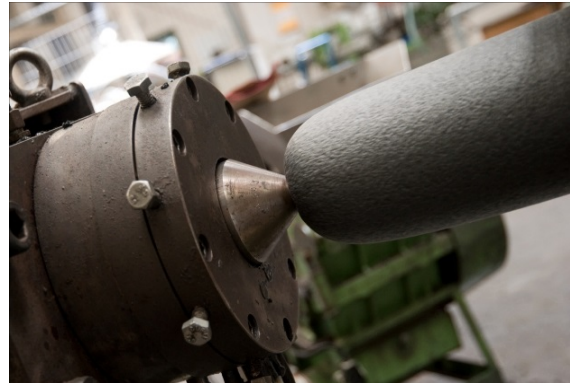
Fig.5 Example: stress crack corrosion

## Physical blowing agents

With physical blowing agents, a gas is dissolved in the melt under high pressure in an extruder. As soon as this is exposed to atmospheric pressure outside the extruder, the conversion from the liquid phase to the gas phase leads to a volume expansion.



**Fig. 6**  
Schematic illustration of physical foaming



**Fig. 7**  
Expansion under atmospheric pressure

## Conclusion

Clear is that with the use of insulation materials produced with chemical blowing agents, extra attention should always be given to the prevention of stress crack corrosion for all components that are to be insulated with insulation products that are foamed using the blowing agent ADC. With a foam produced with a physical blowing agents, this form of corrosion does not form any risk.

With cold applications, it is of course key to also secure a vapor-tight defense of all seams as well as section adhesion in order to prevent the intrusion of outside air and condensation underneath the insulation.

### Further information:

Questions concerning the paper can be addressed to:

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