Ammonium Sulfate

Ammonium sulfate is being considered as a fire-retardant chemical for cellulose insulation. Since it has many uses (Reference 1) such as fertilizers, fermentation, viscose rayon, tanning and food additives, it should be user safe in cellulose insulation. However, on closer inspection, ammonium sulfate has some characteristics, which make it unsuitable as a fire retardant for cellulose insulation.

Reference (2) points out that ammonium sulfate is a "powerful oxidizer." Reference (3) states "ammonium sulfate begins to decompose at 100°C and yields ammonium bisulfate, NH_4HSO_4." Reference (4) indicates that same thing, plus the fact that ammonium bisulfate, NH_4HSO_4, is "completely volatile on heating and decomposes at a temperature above 280°C (536°F)." Reference (5) sates that "all ammonium salts decompose into ammonia and the acid when heated." Reference (2) comments on the disaster hazard of ammonium sulfate by stating that "when heated to decomposition it emits very toxic fumes NO_X,NH_3, and SO_X."

Let us examine what this means. The references (4) and (5) reactions are as follows:

Ammonium Sulfate $\xrightarrow{\text{at 100°C}}$ Ammonium bisulfate + Ammonia

at 212°F

$[(NH_4)_2\ SO_4]$ $[NH_4HSO_4]$ $[NH_3]$

Ammonium bisulfate $\xrightarrow{\text{at 280°C}}$ Ammonia + Sulfur trioxide + Water

at 536°F

$[(NH_4)2\ SO_4]$ $[NH_3]$ $[SO_3]$ $[H_2O]$

By Reference (7), if sulfur dioxide, SO_2, is also produced, it reacts with oxygen above 400°C to produce sulfur trioxide and the release of heat. Thus, sulfur trioxide is the probable product produced. Reference (6) indicates that "SO_3 is highly reactive" and Reference (7) states that sulfur trioxide reacts vigorously with water to form sulfuric acid (H_2SO_4) with the release of heat.

From Reference (7), under fire conditions, ammonia can also produce nitric oxide and nitrogen dioxide in a reaction with the oxygen in the air. These products will produce nitric acid. These are all unacceptable for human exposure.

From the foregoing analysis it is seen that whenever ammonium sulfate is heated to the boiling point of water it gives off ammonia and, at roughly the ignition temperature of cellulose, the chemical decomposes to make ammonia plus sulfur trioxide. This is not the type of chemical to retard fires because the products of decomposition in a fire are dangerous to the occupants of the burning building exposed to the fumes as well as to the firefighters. To be explicit, both ammonia (7,8) and sulfur trioxide (7) are very poisonous and hazardous to humans. Ammonium sulfate is definitely not the chemical to use in cellulose insulation in buildings where humans can be adversely affected.

Since ammonium sulfate tends to decompose, it raises the question "How long will it give the cellulose insulation fire retardant properties?" This lack of permanency is something that should be examined before a dangerous hazard results. In other words, as the chemical composes it would lose its fire retardant characteristics.

Another point for concern is corrosion. Reference (2) and Reference (4) make reference to corrosion and indicates that in the presence of momel metal corrosion is prevented. Further, it is hard to buffer a chemical that can decompose to corrosive compounds. Indeed, over the years, various cellular insulation manufactures have tried to use ammonium sulfate and thought that they were successful in preventing corrosion. However, surprises occurred and corrosion resulted under unexplained circumstances. Again, this could be attributed to the low temperature decomposition.

With ammonium sulfate's decomposition characteristics producing toxic products and possible poor long-term fire retardancy and uncontrolled, corrosion characteristics, it should not be considered as a fire retardant chemical for cellulose insulation.

References

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3. "Encyclopedia of Chemical Technology," Vol.2, 3rd Ed. By Kirk-Othmer. ISBN 0-471-02038-0

4. "Foods and Food Production Encyclopedia," by Douglas M. Considine and Glen D. Considine.

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7. "General Chemistry for Colleges," by Herman T. Briscoe, 1938.

8. "Fire Protection Guide on Hazardous Material," 7th Ed., NFPA, National Fire Protection Association.