Case Study 7 – Paint Can Failure Analysis

Related to an insurance claim, this consultant was hired to determine the conditions leading to an aerosol paint can failure resulting in injury.

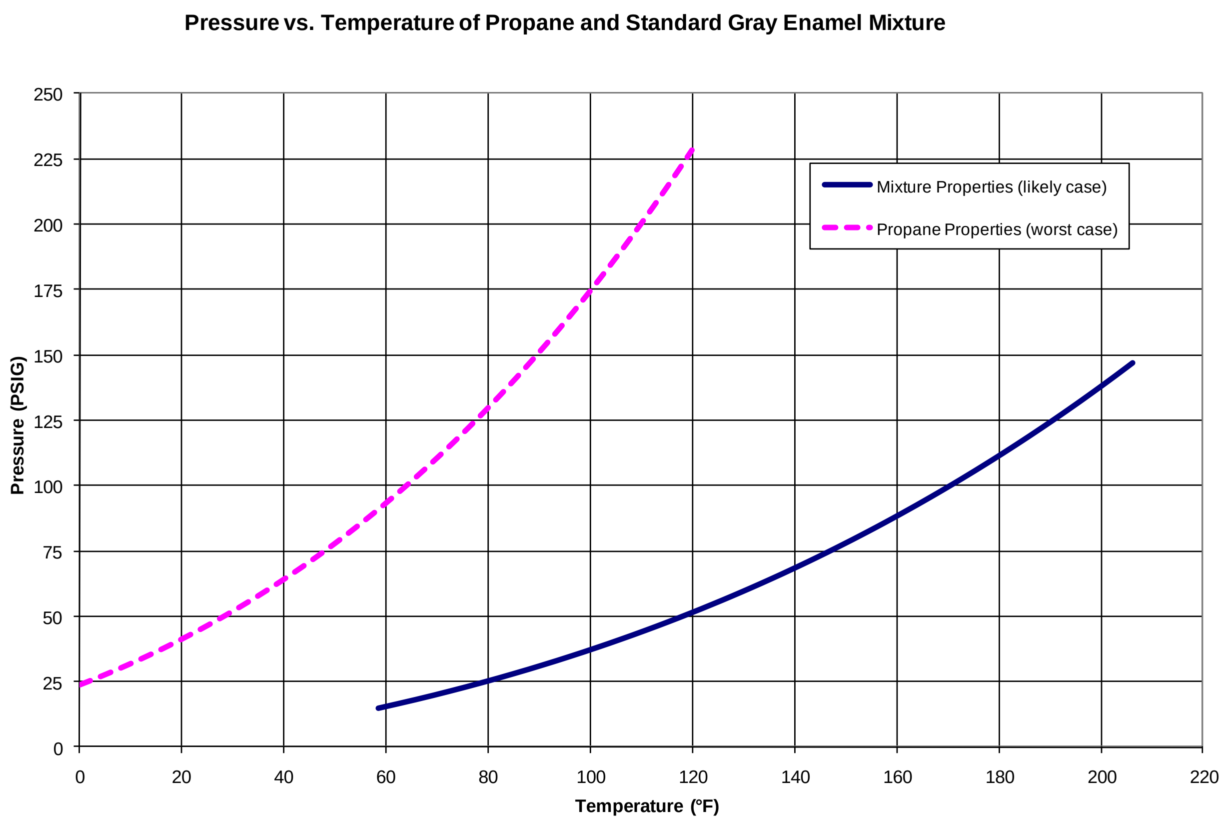
A paint container of standard gray spray enamel was stated to fail while in the possession of a worker after the can had been setting on the ground and near a gravel pile. The can exploded in the worker's hands when the ambient temperature was approximately 70°F.

To determine the likelihood that the contents of the can approached or exceeded the normal pressure rating of the can, a computer simulation using Aspen Plus® was used to generate a curve representing the pressure/temperature relationship of the paint solvent mixture. The solvent mixture was obtained from a Material Safety Data Sheet (MSDS) that corresponded with the paint identification number. The solvent mixture is described in the following table:

Solvent	**Composition (wt%)**
Propane	15
Toluene	3
Ethyl Benzene	0.4
Xylene	2
2-Propanol	3
1-Butanol	1
Acetone	49
Methyl Ethyl Ketone	5
Ethyl 3-Ethyoxypropionate	7
N-Butyl Acetate	5
Titanium Dioxide (non-volatile)	2
Total	92.4

Note that the total composition does not add up to 100%. For the evaluation, the solvent mixture was normalized to 100%.

Using the normalized solvent composition, the simulator determined the mixture properties, specifically the pressure/temperature curve.



Over a temperature range of 70°F to 120°F (highest recommended temperature posted on the label), the pressure inside the paint container should vary between 20 and 50 pound per square inch gauge (psig). In the worst case scenario (where the pressure of the can would be influenced by propane only), the pressure would vary between 110 and 225 psig in the same temperature range. The simulator was also used to identify any non-ideal component interactions in the solvent mixture (component interactions that could cause higher pressures than any individual component). The evaluation shows that some interactions exist, but have no significant impact on elevating the pressure of the mixture in the in the temperature range being considered. Since the mixture contains propane as a propellant, appropriate equation-of-state property methods were used to predict the mixture pressure versus temperature, neglecting component interactions.

To determine the impact of the internal pressure of the solvent mixture, the pressure rating of the aerosol container must be determined. The table below represents the U.S. Department of Transportation regulations that all aerosol cans must adhere to:

Pressure Rating	Min. Buckle (PSIG)	Min. Burst (PSIG)
Non-Spec	140	210
2P	160	240
12 Bar	174	208
2Q	180	270
18 Bar	261	313

The exact specification of the paint container could not be confirmed, but the table suggests that even the most conservative choice of burst pressure is well above the pressure range predicted above for the likely case. In other words, the temperature of the can would have to reach well over 200F to reach the most conservative burst pressure. An internal temperature of even 120F appears unlikely for the ambient conditions described by the client.

The more probable cause of the can explosion is the premature failure of the cylinder seam joint. By observing the failed container, the cylinder seam was completely separated, while the top and bottom caps of the can were still partially attached. The exact cause of the seam failure would take significant structural analysis, and is not contained in the scope of this evaluation.