

Vapor Pressure of Hydrogen Bromide* Solutions

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Enviro Tech has introduced a new antimicrobial formulation based on a 24% hydrogen bromide (HB2 and HB3) precursor that food plants will be using to control bacteria levels on beef carcasses and poultry during processing. This chemical is new to the food processing industry and limited physicochemical information is available. In particular, the question arises “would the vapor pressure of HBr give rise to fumes that would pose a health hazard to plant personnel?” In response to this concern, Enviro Tech used the vapor pressure equation presented in the paper “Thermodynamic Description of the Electrolytic Mixed System HBr-H₂O at Moderate Pressures by Use of Gas Phase p, v, T and Total Pressure Measurements”, G. Wüster *et al.*, in Fluid Phase Equilibria, 6 p.93-111 (1981); to calculate the vapor pressure of a solution closest to that of the HBr.

In the above study, the authors prepared a series of HBr solutions varying in concentration from 7.96% to 65.01%. They then measured the vapor pressure of these solutions at temperatures up to 500 °C. The experimental data was used to map a mathematical model expressing how the vapor pressure varied as a function of HBr concentration and temperature. Although 24% HBr was not included in the paper’s study, data was presented for 19.99% HBr. Therefore, the equation for 19.99% HBr was used to determine the vapor pressure.

Using the mathematical model, the vapor pressure of a 19.99% HBr system at 20°C was determined to be 10.55 mm Hg; therefore a 24% HBr solution at 20°C can be assumed to be only slightly higher. This vapor pressure is considerably low. To fully understand how minimal the vapor pressure is for the HBr, a comparison was made between 19.99% HBr and commonly-used 37% hydrochloric acid (HCl). This solution has a reported vapor pressure of 210 mm Hg at 25 °C. Organoleptic (odor), and visual comparisons were also performed. The results are summarized below.

Comparison between 19.99% HBr and 37% HCl

Solution	Temperature (°C)	Vapor Pressure	Odor	Vapors
19.99% HBr	20	10.55 mm Hg	None	No visible vapors
37% HCl	25	210 mm Hg	Strong	Visible vapors

In addition, several other chemicals and compounds have widely reported vapor pressures. Some examples of which are: note: 17.5 mm Hg = 1 bar (or atm)

- a) WD-40 (lubricant): 110 mm Hg @ 20° C
- b) Ethanol 100%: 45 mm Hg @ 20° C
- c) *Water*: 17.5 mm Hg @ 20° C

We would like to highlight that 24% HBr solutions exhibit less tendency to vaporize as does plain water, and based on the data presented above, it is our conclusion that the low vapor pressure of HB2 and HB3 solutions will not result in fumes that would be irritating or noticeable to plant personnel.

We would caution the reader not to confuse Enviro Tech’s 24% HBr solutions with that of *anhydrous* hydrobromic acid, which is a very volatile gas and dangerous compound, but is used as the basis for many regulatory safety references. The FDA and FSIS recognized this difference, and it is the reason these regulatory Agencies approved hydrogen bromide as the acceptable precursor, and not hydrobromic acid.

*Method of use for sodium and hydrogen bromide Patent Pending by the U.S. PTO