REPORT ON STEAM PRESSURE

In general the pressure of dilute steam is well described by the ideal gas law:

$$P = \rho \left(\frac{R}{M}\right) T \quad - (1)$$

where ρ is the density, M the molar mass (0.018 kilograms for steam), and R is the ideal gas constant:

$$R = 8.314 \text{ J mole}^{-1} \text{K}^{-1} \quad - (2)$$

in SI units. Here R and M are constants, so:

$$P = 461.9 \rho T \quad - (3)$$

and the pressure is proportional to density multiplied by temperature. To keep the pressure low we therefore minimize density for a given temperature, i.e. use dilute steam, where the ideal gas law holds to a very good approximation. Another form of Eq. (1) is:

$$P = NkT / V \quad - (4)$$

where k is Boltzmann's constant and N the number of steam molecules. There are other forms of the gas law such as the Dieterici equation of state:

$$P(V - b) = RT \exp\left(-\frac{a}{RTV}\right) \quad - (5)$$

but this is needed only for steam under high pressure, where there is strong molecular interaction. In addition, if steam emerges from a nozzle, its rapid evaporation will tend to produce cooling, so the pressure is decreased as the steam expands. As the latter occurs the density and temperature both decrease, so pressure is decreased considerably. This is how the pressure is kept low in the Steriwave systems. If we choose the steam density to be that of dilute steam (0.01 kilogram per cubic metre, for the sake of illustration), the pressure for a range of temperatures is given in the following Table

Pressure / $\text{Jm}^{-3}\text{mole}^{-1}$	Temperature / K
1260	273
1353	293
1617	350
1848	400
2079	450

Conversion Factors

$$1 \text{ bar} = 1.01325 \times 10^5 \ Jm^{-3},$$

$$P(\text{bar}) = 0.00456 \rho T.$$

Therefore as the following table shows, the pressure can be maintained low by suitable choice of steam density.

$\rho = 10^{-4}$ gm per c.c.

P (bar)	T / C
0.180	120
0.184	130
0.188	140

Signed

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