with $\epsilon_i(x_il) = (x_il)^3K_1(x_il) + 3(x_il)^2K_2(x_il)$, where K_1 and K_2 are the modified Bessel functions with $x_i = \frac{m_i}{T}$ and index i runs for gluons, up-down quarks q, and strange quark s. Here d_i are the degeneracies associated with the internal degrees of freedom. Now, by using the thermodynamic relation $\epsilon = T\frac{\partial p}{\partial T} - p$, pressure of system at $\mu_q = 0$ can be obtained as:

$$\frac{p(T,\mu_q=0)}{T} = \frac{p_0}{T_0} + \int_{T_0}^{T} dT \frac{\epsilon(T,\mu_q=0)}{T^2}, \tag{15}$$

where p_0 is the pressure at a reference temperature T_0. We have used p_0=0 at T_0=100 MeV in our calculation. Using the relation between the number density n_q and the grand canonical partition function, we can get the pressure for a system at finite μ_B :

$$p(T,\mu_q) = p(T,0) + \int_0^{\mu_q} n_q d\mu_q. \tag{16}$$

Thus all the thermodynamical quantities can be obtained in a consistent way by using this model.

V. EOS FOR A HADRON GAS

There is no deconfinement transition, if the hadron gas consists of point-like particles, and consequently HG pressure is always larger than QGP pressure. Therefore, inclusion of a repulsive interaction between two baryons having a hard-core size reduces the HG pressure and hence it stabilizes the formation of QGP at high baryon densities. Recently we have proposed a thermodynamically consistent excluded volume model for hot and dense hadron gas (HG). In this model, the grand canonical partition function for the HG with full quantum statistics and after incorporating excluded volume correction can be written as [25]:

$$\begin{aligned} lnZ_i^{ex} = \frac{g_i}{6\pi^2 T} \int_{V_i^0}^{V-\sum_j N_j V_j^0} dV \\ \int_0^{\infty} \frac{k^4 dk}{\sqrt{k^2+m_i^2}} \frac{1}{[exp\left(\frac{E_i-\mu_i}{T}\right)+1} \end{aligned} \tag{17}$$

where g_i is the degeneracy factor of ith species of baryons,E_i is the energy of the particle ($E_i = \sqrt{k^2+m_i^2}$), V_i^0 is the eigenvolume of one baryon of ith species and $\sum_j N_j V_j^0$ is the total occupied volume and N_j represents total number of baryons of jth species.

Now we can write Eq.(17) as: