ChE 4133 **Homework #1** **Due: February 2, 2017**

Industrial Catalysis

I. Attached are three isotherms for N_2 adsorption at 78 °K for non-porous silica particles. (Note these are in volume of liquid adsorbed. Use $\rho_{LN2} = 0.807$ g/cm^3 for conversion to V^{stp}_{Ads}.) The three isotherms correspond to loose powder, pressed tablet-adsorption branch, and pressed tablet-desorption branch. The basic reason that the isotherms are different is that the process of making tablets creates pores that interconnect between the small particles.

1. Estimate the surface area of the loose powder using the B.E.T. isotherm. Assuming that the particles are non-porous spheres with a density of 2.23 gr/cm^3, compute the average particle size.

2. Make rough estimates of the average pore diameter in the pressed pellets from:

   a) geometric considerations using the particle diameter
   b) using the desorption isotherm for the pressed pellet
   c) using $\bar{r} = 2V_g/S_g$.

These calculations are most easily done by first plotting all the isotherms on a single diagram. Note where the bulk of the desorption takes place from the pressed tablet desorption branch and compute the pore radius from the Kelvin equation. For geometric considerations, think about how the particles would pack and what the pore space between them would look like. The pore volume may be found by examining the adsorption curve as $P/P_o \rightarrow 1.0$.

Data for Problem I.

Loose Powder		Pressed Tablet Adsorption Isotherm		Pressed Tablet Desorption Isotherm	
P/P_O	V_{ADS}-LIQUID (cm^3/g)	P/P_O	V_{ADS}-LIQUID (cm^3/g)	P/P_O	V_{ADS}-LIQUID (cm^3/g)
0.0687	0.0653	0.0251	0.0532	0.2548	0.0909
0.1335	0.0767	0.0993	0.0692	0.5392	0.1274
0.1849	0.0794	0.1657	0.0790	0.6145	0.1423
0.2279	0.0832	0.2258	0.0880	0.6689	0.1576
0.2621	0.0849	0.2406	0.0870	0.7121	0.1743
0.3565	0.0958	0.2791	0.0907	0.7493	0.1898
0.4627	0.1061	0.3726	0.1012	0.7736	0.2029
0.5488	0.1142	0.4588	0.1122	0.7911	0.2262
0.6277	0.1225	0.4964	0.1156	0.8121	0.2517
0.7051	0.1362	0.5414	0.1216	0.8343	0.2827
0.7726	0.1506	0.6387	0.1378	0.8507	0.3143
0.8399	0.1723	0.7127	0.1602	0.8592	0.3497
0.8788	0.1925	0.7663	0.1823	0.8623	0.3879
0.8962	0.2107	0.7953	0.2048	0.8780	0.4232
0.9269	0.2337	0.8338	0.2434	0.8807	0.4495
0.9482	0.2792	0.8662	0.2865	0.8924	0.4694
		0.8793	0.2906	0.9745	0.4700
		0.8826	0.3085	1.0000	0.4744
		0.9052	0.3796		
		0.9112	0.4061		
		0.9205	0.4268		
		0.9336	0.4529		
		0.9458	0.4658		
		0.9741	0.4760		
		0.9977	0.4802		

II. For the adsorption of N_2 on Fe - Al_2O_3 ammonia synthesis catalyst at -195°C (78°K), the following data were obtained on a 50.4 g sample:

P (torr)	V_{ADS} cm^3 (STP)
8	103
30	116
50	130
102	148
130	159
148	163
233	188
258	198
330	221
442	270
480	294
507	316
550	365

1. Find the surface area using the B.E.T. Equation.

2. Make a plot of amount adsorbed versus P/P_o and mark V_{ADS} corresponding to 1 monolayer (i.e. point B). Extrapolate the linear region and see if you could have identified point B in the classical sense.

3. For the region $P < 200$ torr, try to fit Langmuir, Tempkin, and Freunlich isotherms. Find the parameters by linear regression for each equation and plot the theoretical curves along with the data.