Calculating the Lifting Force of Suction Cups

Below is a convenient chart that will give you the calculated theoretical weights of different diameter suction cups will lift using various degrees of vacuum.

In using this chart, keep in mind that it's best not to start with the smallest diameter suction cup you can buy, because you'll need lots of vacuum to make it work. Try to use the largest cup possible to ease the load on your vacuum pump. It's far easier and more economical to get an adequate-sized suction cup than to overload your vacuum pump. This way, you'll help assure a long pump life.

To use this chart, first determine the weight you want to lift. Weight figures in pounds are shown in the nine vertical columns under the "inches Hg vacuum" heading. Then locate the weight figures closest to your needs under one of the columns listing the appropriate amount of vacuum you have available.

The proper suction cup diameter for the weight you wish to lift can then be determined by looking at the figures in the "suction cup diameter" column at the left, opposite the weight figures you have chosen.

Figures shown in the chart are the theoretical calculated ones for these weights. Therefore, after you find what suction cup diameter you need under these theoretical conditions, you should add a safety factor commensurate with your particular lifting application. For example, you should allow for conditions such as the type of load you are picking up, the conditions under which you are picking up the load, the suction cups used, and the vacuum you have available.

Choosing a slightly larger cup also adds safety to your system. A safety factor should always be used in actual cup sizing too, even though cup diameter increases about 10% during use. If the object is lifted vertically, a safety factor of four (4x) should be used. For horizontal movement, a safety factor of two (2x) is recommended.

Acceleration during the lift is another important factor to consider when sizing vacuum cups. Formulas exist to calculate the affect of acceleration, but they are very difficult to work with. It is easiest and perhaps best to use a higher safety factor and carefully test cups in these applications.

It's not uncommon to apply a 200 to 500 percent extra margin of lifting power. Each situation is different, of course.

Since different shape suction cups are available, we're also including the following two formulas to help you calculate lifting force.

Using the formula:

lbs = Area (sq. in.) X .49 (inHg); lbs = Pi 2 X .49 (inHg)

Calculated Lifting Force in Pounds

SUCTION CUP DIAMETER	5 inHg	10 inHg	15 inHg	20 inHg	22 inHg	24 inHg	26 inHg	27 inHg	28 inHg
1"	2	4	6	8	8.5	9	10	10.5	11
2"	8	15	23	31	34	37	40	42	43
3"	17	35	52	69	76	83	90	94	97
4"	31	62	93	123	136	148	160	167	173
5"	48	96	145	193	212	231	251	260	270
6"	69	139	208	278	306	333	361	375	389
7"	95	189	284	378	416	454	491	510	529
8"	123	247	370	494	543	593	642	667	691
9"	156	312	469	625	687	750	812	843	875
10"	193	386	579	772	849	926	1003	1042	1080
11"	233	467	700	934	1027	1120	1214	1260	1307
12"	278	556	833	1111	1222	1333	1444	1500	1556
13"	378	756	1134	1512	1664	1815	1966	2042	2117
15"	434	868	1302	1736	1910	2083	2257	2344	2430