

Technical Memo

AIR COMPRESSOR POWER AT ALTITUDE

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CORE IDEA:

Naturally aspirated engines are understood to lose approximately 3% of their rated horsepower per 1,000' of elevation. Additionally, air compressors are acting on a lower density suction air supply. When an air compressor draws in air as part of its intake process, it draws a fixed volume of air. If the air density is lower, fewer air molecules are drawn in with this air into the compressor. This results in a smaller volume of compressed air and less air is delivered during each compression cycle. Another way to think about this effect is to say "the lighter the air going into an air compressor, the more ambient air needed to do the same work." The combination of these two factors (more air required, and less engine power to provide it) leads to lower air compressor performance, and therefore should be compensated when planning ZEVAC projects. There are other altitude related effects such as lower ambient humidity, lower ambient temperature, and reduced cooling capacity of radiators that are beyond the scope of this memo.

SUMMARY:

ALTITUDE	ENGINE HORSEPOWER	ATMOSPHERIC PRESSURE (PSIA)	SUCTION AIR DENSITY	COMBINED AIR SUPPLY LOSS	185 SCFM =	375 SCFM =	750 SCFM =
0	100.0%	14.7	100.0%	0.0%	185	375	750
500	98.5%	14.4	98.1%	3.4%	179	362	724
1000	97.0%	14.2	96.3%	6.7%	173	350	700
1500	95.5%	13.9	94.6%	9.9%	167	338	676
2000	94.0%	13.7	92.9%	13.1%	161	326	652
2500	92.5%	13.4	91.2%	16.3%	155	314	628
3000	91.0%	13.2	89.5%	19.5%	149	302	604
3500	89.5%	12.9	87.9%	22.6%	143	290	580
4000	88.0%	12.7	86.3%	25.7%	137	278	557
4500	86.5%	12.5	84.7%	28.8%	132	267	534
5000	85.0%	12.2	83.1%	31.9%	126	255	511
5500	83.5%	12.0	81.6%	34.9%	120	244	488
6000	82.0%	11.8	80.1%	37.9%	115	233	466
6500	80.5%	11.6	78.6%	40.9%	109	222	443
7000	79.0%	11.3	77.1%	43.9%	104	210	421
7500	77.5%	11.1	75.6%	46.9%	98	199	399
8000	76.0%	10.9	74.2%	49.8%	93	188	377
8500	74.5%	10.7	72.8%	52.7%	88	177	355
9000	73.0%	10.5	71.4%	55.6%	82	167	333
9500	71.5%	10.3	70.1%	58.4%	77	156	312
10000	70.0%	10.1	68.7%	61.3%	72	145	290

BACKGROUND INFORMATION:

<https://www.atlascopco.com/en-us/compressors/wiki/compressed-air-articles/dimensioning-compressor-installations-at-high-altitudes>

<https://www.vmacair.com/blog/compressor-system-perform-differently-higher-altitudes/#:~:text=At%20higher%20altitudes%2C%20air%20compressor,be%20working%20slower%20than%20normal.>

<https://www.pdblowners.com/tech-talk/elevation-versus-atmospheric-pressure/>

<https://www.airbestpractices.com/technology/air-compressors/the-impact-of-altitude-on-air-compressor-and-tool-sizing>

<https://trident.on.ca/engineering-information/oil-free-acfm-scfm-altitude-corrections/>

<http://www.assakkaf.com/courses/ence420/lectures/chapter11.pdf>

<https://www.hitachi.us/ice/wecompressair/assets/hitachi-ambient-air-impact.pdf>