SCFM vs ACFM

Are you REALLY getting the blower performance you're specifying?

DRESSER
Roots

R-SCFM-ACFM-0207

SCFM (Standard CFM) vs. ACFM (Actual CFM)

In specifying blower performance, major problems often occur in distinguishing ACFM from SCFM, and in correctly converting from one to the other. Some people even use SCFM and ACFM interchangeably.

SCFM is normally used to designate flow in terms of some base or reference pressure, temperature and relative humidity. Many standards are used, the most common being the Compressed Air & Gas Institute (CAGI) and the American Society of Mechanical Engineers (ASME) standards, which are 14.7 PSIA, 68°F and 36% RH. This converts to a density of 0.075 lbs/cu. ft. for air.

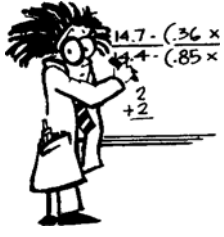
SCFM is usually established from a weight flow corresponding to some system requirement for oxygen. Therefore, if actual site conditions are different from the standard or reference conditions, corrections **must** be made to reflect the **actual** conditions of pressure, temperature and relative humidity (i.e., convert to ACFM). Blower performance calculations, including head and horsepower, are based on **actual** (not **standard**) conditions existing at the inlet and outlet connections of the **blower**.

These corrections must, therefore, be made to assure that the blower furnished will provide the proper amount of oxygen or other elements for the process to function properly.

NOTE: The procedures outlined in this booklet apply for ambient air only. Conversion from SCFM to ACFM for other gasses requires additional considerations.

To convert SCFM to actual flow (ACFM) at any other pressure, temperature or relative humidity conditions, the formula used is:

$$ACFM = SCFM \times \frac{P_s - (RH_s \times PV_s)}{P_b - (RH_a \times PV_a)} \times \frac{T_a}{T_s} \times \frac{P_b}{P_a}$$



Where:

P_s	=	Standard pressure (PSIA)
P_b	=	Atmospheric pressure – barometer (PSIA)
P_a	=	Actual pressure (PSIA)
RH_s	=	Standard relative humidity
RH_a	=	Actual relative humidity
PV_s	=	Saturated vapor pressure of water at standard temperature (PSI)*
PV_a	=	Saturated vapor pressure of water at actual temperature (PSI)*
T_s	=	Standard temperature (°R) NOTE: °R = °F+460
T_a	=	Actual temperature (°R)

*See Chart on page 12

BLOWER EXAMPLE;

Assume 7000 SCFM, measured at standard or reference conditions of 14.7 PSIA, 68 °F, and 36% RH, is required by the process.

However, actual site conditions are:

Barometer (P_b)	14.4 PSIA
Suction Pressure (P_a)	14.2 PSIA*
Suction Temperature (T_a)	100°F (or 560 °R)
Relative Humidity (RH_a)	85%
Discharge Pressure (P_d)	24.7 PSIA (10.3 PSIG + 14.4 PSIA Barometer)

NOTE: These examples all use a discharge pressure of 24.7 PSIA so the following comparisons will show how the brake horsepower required for the blower will vary with a fixed discharge pressure for each case.

*The difference between the 14.4 PSIA barometer and 14.2 PSIA suction pressure denotes a 0.2 PSIA system pressure drop ahead of the blower, likely the result of losses through inlet filter, silencer, piping, etc. (often overlooked!).

CASE A

Using the formula on page 2, the **correct** conversion is:

$$ACFM = 7000 \times \frac{14.7 - (.36 \times .3391)}{14.4 - (.85 \times .9503)} \times \frac{560}{528} \times \frac{14.4}{14.2} = 8075$$

Therefore, **correctly done**, converting from 7000 SCFM at 14.7 PSIA, 68°F and 36% RH, to ACFM at actual site conditions:

Case	A	Case	A
P_a (PSIA)	14.2	Mol. Wt.	28.35
T_a (°F)	100	ACFM	8075
RH_a (%)	85	Head (Ft-Lbs/Lb)	18685
P_d (PSIA)	24.7	BHP	397.8

NOW LET'S DO IT SEVERAL **INCORRECT** WAYS TO DETERMINE THE CONSEQUENCES!

THERE ARE A VARIETY OF WAYS THAT THE CONVERSION CAN BE MISHANDLED.
Some of the more common errors made in SCFM-ACFM conversions are:

1. Neglecting the inlet pressure drop.
2. Neglecting the relative humidity.
3. Using the SCFM as ACFM.
4. Using standard conditions with no corrections.

The following examples shown in Cases “B” thru “G” are **incorrect** conversions of the process requirements (and therefore blower operating conditions).

CASE B

NEGLECT THE INLET PRESSURE DROP

$$ACFM = 7000 \times \frac{14.7 - (.36 \times .3391)}{14.4 - (.85 \times .9503)} \times \frac{560}{528} \times \frac{14.4}{\boxed{14.4}} = 7963$$

Case	A	B
P_a (PSIA)	14.2	14.4
T_a (°F)	100	100
RH_a (%)	85	85
P_d (PSIA)	24.7	24.7
Mol. Wt.	28.35	28.35
ACFM	8075	7963
Head (Ft-Lbs/Lb)	18685	18165
BHP	397.8	387.0

CASE C

NEGLECT THE RELATIVE HUMIDITY

$$ACFM = 7000 \times \frac{14.7 - \boxed{(0 \times .3391)}}{14.4 - \boxed{(0 \times .9503)}} \times \frac{560}{528} \times \frac{14.4}{14.2} = 7686$$

Case	A	B	C
P_a (PSIA)	14.2	14.4	14.2
T_a (°F)	100	100	100
RH_a (%)	85	85	0
P_d (PSIA)	24.7	24.7	24.7
Mol. Wt.	28.35	28.35	28.967
ACFM	8075	7963	7686
Head (Ft-Lbs/Lb)	18685	18165	18288
BHP	397.8	387.0	379.1

CASE D

NEGLECT INLET PRESSURE DROP AND RELATIVE HUMIDITY

$$ACFM = 7000 \times \frac{14.7 - \boxed{(0 \times .3391)}}{14.4 - \boxed{(0 \times .9503)}} \times \frac{560}{528} \times \frac{14.4}{\boxed{14.4}} = 7579$$

Case	A	B	C	D
P_a (PSIA)	14.2	14.4	14.2	14.4
T_a (°F)	100	100	100	100
RH_a (%)	85	85	0	0
P_d (PSIA)	24.7	24.7	24.7	24.7
Mol. Wt.	28.35	28.35	28.967	28.967
ACFM	8075	7963	7686	7579
Head (Ft-Lbs/Lb)	18685	18165	18288	17780
BHP	397.8	387.0	379.1	368.9

CASE E

USE SCFM AS ACFM, USE INET PRESSURE DROP AND ACTUAL RELATIVE HUMIDITY

Case	A	B	C	D	E
P_a (PSIA)	14.2	14.4	14.2	14.4	14.2
T_a (°F)	100	100	100	100	100
RH_a (%)	85	85	0	0	85
P_d (PSIA)	24.7	24.7	24.7	24.7	24.7
Mol. Wt.	28.35	28.35	28.967	28.967	28.35
ACFM	8075	7963	7686	7579	7000
Head (Ft-Lbs/Lb)	18685	18165	18288	17780	18685
BHP	397.8	387.0	379.1	368.9	346.2

CASE F

USE SCFM AS ACFM, NEGLECT INET PRESSURE DROP AND USE ACTUAL RELATIVE HUMIDITY

Case	A	B	C	D	E	F
P_a (PSIA)	14.2	14.4	14.2	14.4	14.2	14.4
T_a (°F)	100	100	100	100	100	100
RH_a (%)	85	85	0	0	85	85
P_d (PSIA)	24.7	24.7	24.7	24.7	24.7	24.7
Mol. Wt.	28.35	28.35	28.967	28.967	28.35	28.35
ACFM	8075	7963	7686	7579	7000	7000
Head (Ft-Lbs/Lb)	18685	18165	18288	17780	18685	18165
BHP	397.8	387.0	379.1	368.9	346.2	341.4

CASE G

USE STANDARD CONDITIONS WITH NO CORRECTIONS

Case	A	B	C	D	E	F	G
P_a (PSIA)	14.2	14.4	14.2	14.4	14.2	14.4	14.7
T_a (°F)	100	100	100	100	100	100	68
RH_a (%)	85	85	0	0	85	85	36
P_d (PSIA)	24.7	24.7	24.7	24.7	24.7	24.7	24.7
Mol. Wt.	28.35	28.35	28.967	28.967	28.35	28.35	28.88
ACFM	8075	7963	7686	7579	7000	7000	7000
Head (Ft-Lbs/Lb)	18685	18165	18288	17780	18685	18165	16113
BHP	397.8	387.0	379.1	368.9	346.2	341.4	334.2

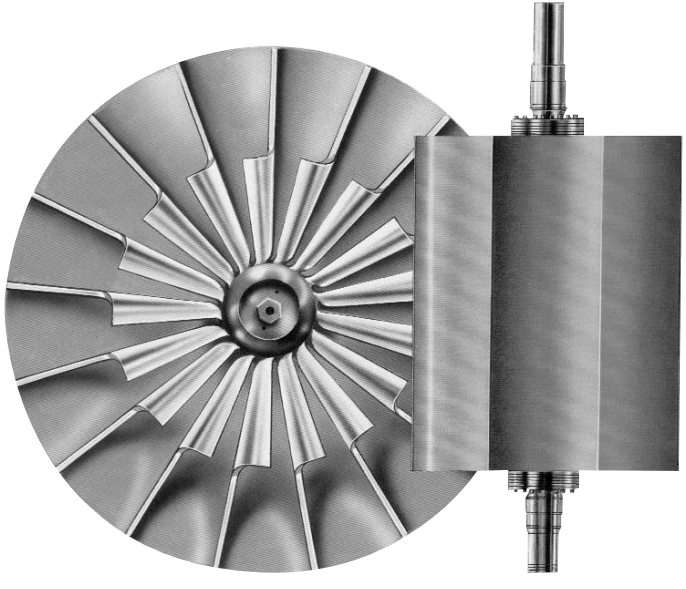
It becomes obvious that, in any specification, ACFM, along with all pressure, temperature and RH conditions, should be clearly spelled out in order to avoid any misunderstanding.

Otherwise , serious consequences can result and blower suppliers will likely not offer equipment of comparable capabilities! In addition, power evaluations will not be correctly analyzed.

VAPOR PRESSURES

Temp Fahr.	Press PSIA	Temp Fahr.	Press PSIA	Temp Fahr.	Press PSIA	Temp Fahr.	Press PSIA	Temp Fahr.	Press PSIA	Temp Fahr.	Press PSIA
32	.08859	47	.15909	63	.2850	79	.4909	95	.8162	111	1.3133
32.018	.08866	48	.16520	64	.2952	80	.5073	96	.8416	112	1.3516
33	.09223	49	.17151	65	.3057	81	.5241	97	.8677	113	1.3909
34	.09601	50	.17803	66	.3165	82	.5414	98	.8945	114	1.4311
35	.09992	51	.18477	67	.3276	83	.5593	99	.9220	115	1.4723
36	.10397	52	.19173	68	.3391	84	.5776	100	.9503	116	1.5145
37	.10816	53	.19892	69	.3510	85	.5964	101	.9792	117	1.5578
38	.11250	54	.20635	70	.3632	86	.6158	102	1.0090	118	1.6021
39	.11700	55	.2140	71	.3758	87	.6357	103	1.0395	119	1.6475
40	.12166	56	.2219	72	.3887	88	.6562	104	1.0708	120	1.6940
41	.12648	57	.2301	73	.4021	89	.6772	105	1.1029	121	1.7417
42	.13146	58	.2386	74	.4158	90	.6988	106	1.1359	122	1.7904
43	.13662	59	.2473	75	.4300	91	.7211	107	1.1697	123	1.8404
44	.14196	60	.2563	76	.4446	92	.7439	108	1.2044	124	1.8915
45	.14748	61	2655	77	.4596	93	.7674	109	1.2399	125	1.9438
46	.15319	62	.2751	78	.4750	94	.7914	110	1.2763	126	1.9974

NOTES



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