Combustion Blowers

June 4, 2019

ASGE Technical Conference

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Combustion Blowers

- Review Fan laws
- Motor
  - torque and system curves
  - Synchronous Speed
  - Starting torques and blower operating torques
- Combustion effects from
  - Speed changes
  - Frequency – 60 to 50 hz
  - Atmospheric - show effects of speed and CO_2
- Dilution Air Blowers

Combustion Blowers

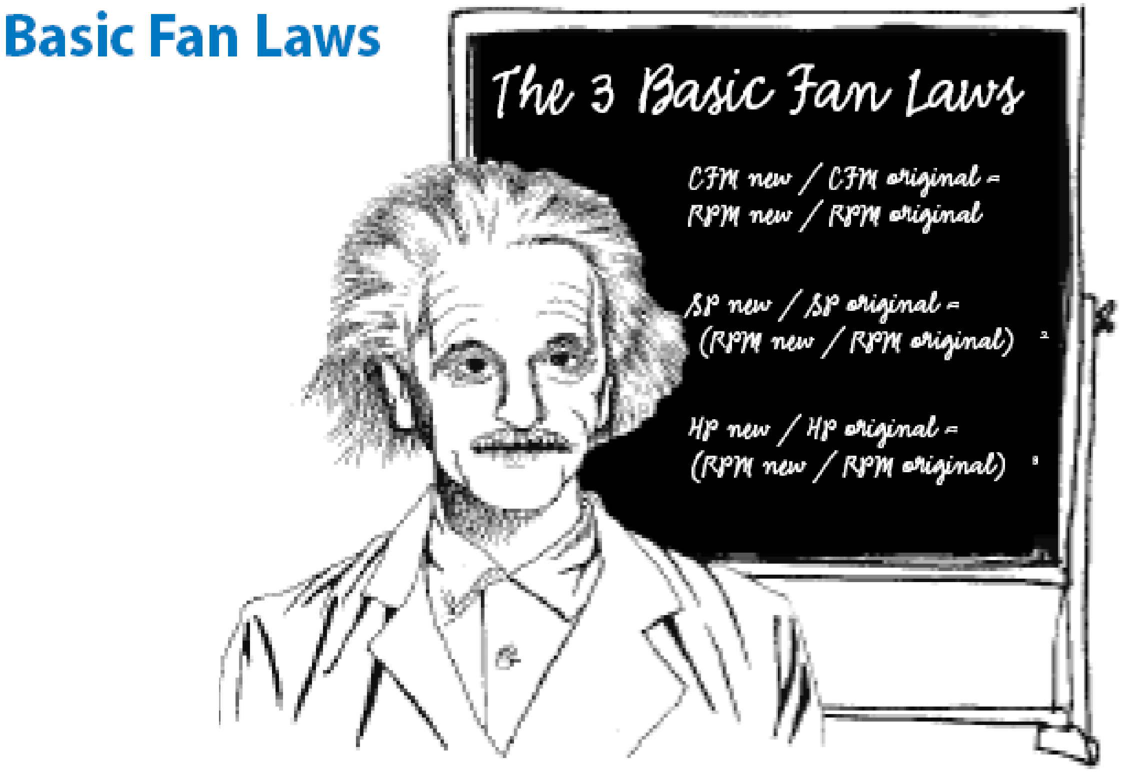
Induced Draft Metal

Non- Condensing

Induced Draft Plastic

Condensing 90+ Appliances

Fan Laws



The 4 Basic Fan Laws:

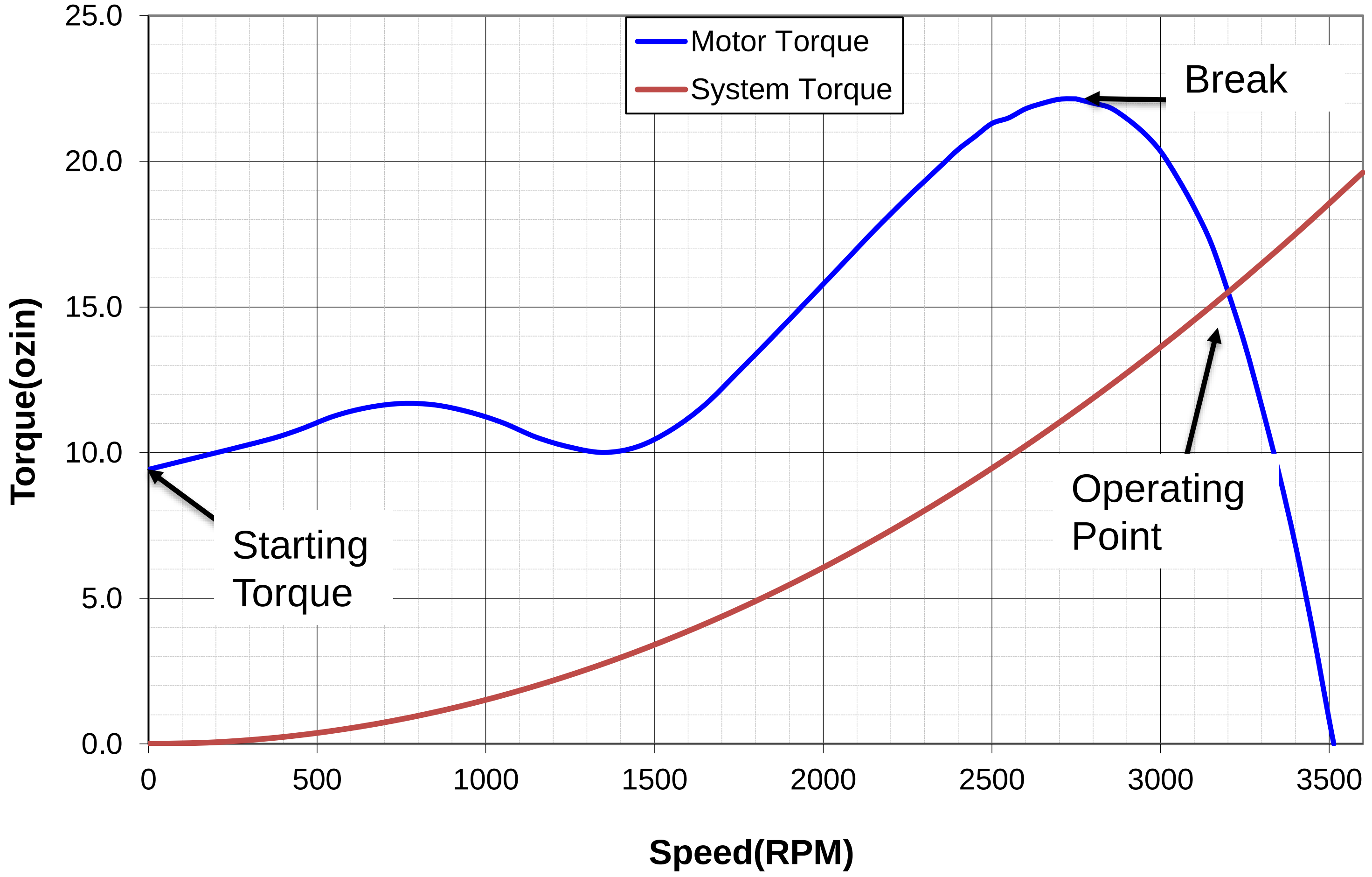
CFM new / CFM original = RPM new / RPM original

CO_2 new/ CO_2 original = CFM original / CFM new

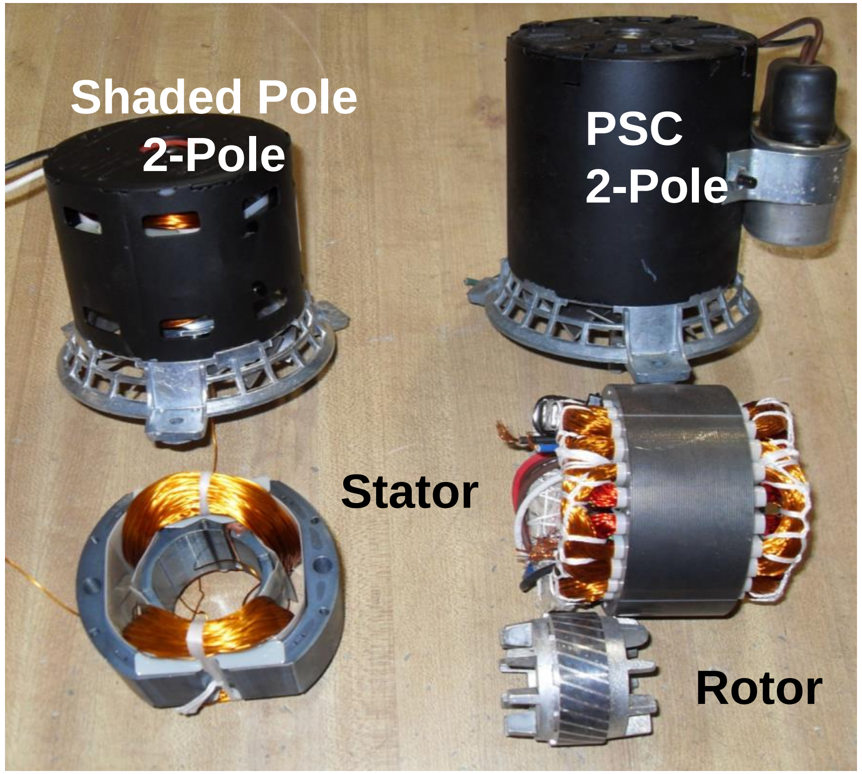
SP new / SP original = (RPM new / RPM original)^2

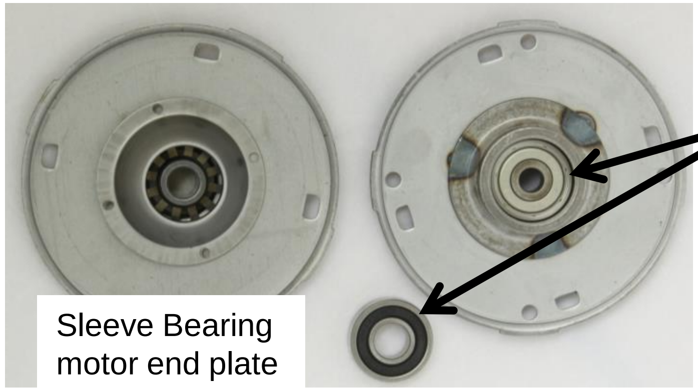
HP new / HP original = (RPM new / RPM original)^3

Motor Torque Curve



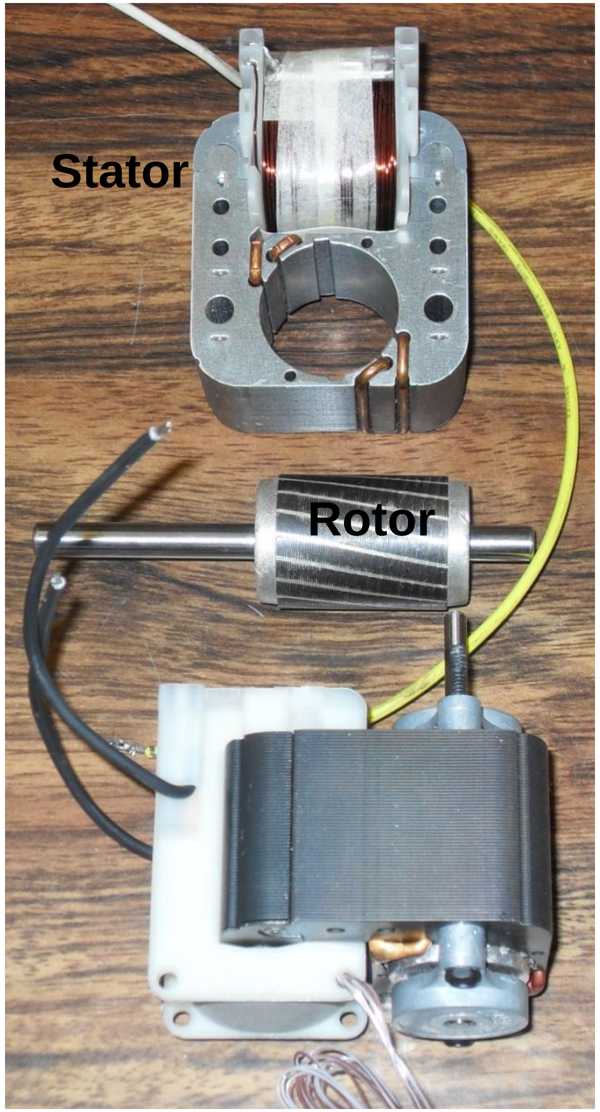
Typical combustion blower motors





Ball Bearing

C-Frame Motor



Motor – Synchronous speed review

- Synchronous Speed =(120 X Line Frequency)/ (#of Poles)
- For 60Hz 2 pole motor. Synchronous Speed = 120 X 60/2 = 3600
- Motor speed would be 3600 – motor slip
- 50Hz – Motor synchronous speed = 3000 – motor slip
- 4 pole motor @ 60Hz = 1800 – motor slip

Speed effect on Combustion

Examples using fan laws and Combustion Calculator – Change blower speed

- Heater Firing Rate = 100kBtu/Hr; Heating Value = 1040 Btu/FT3; CO_2 = 8%
- Total Combustion Air Flow = 25.2 CFM; Static Pressure = 2.2 In W.C.
- Blower speed 3200 RPM

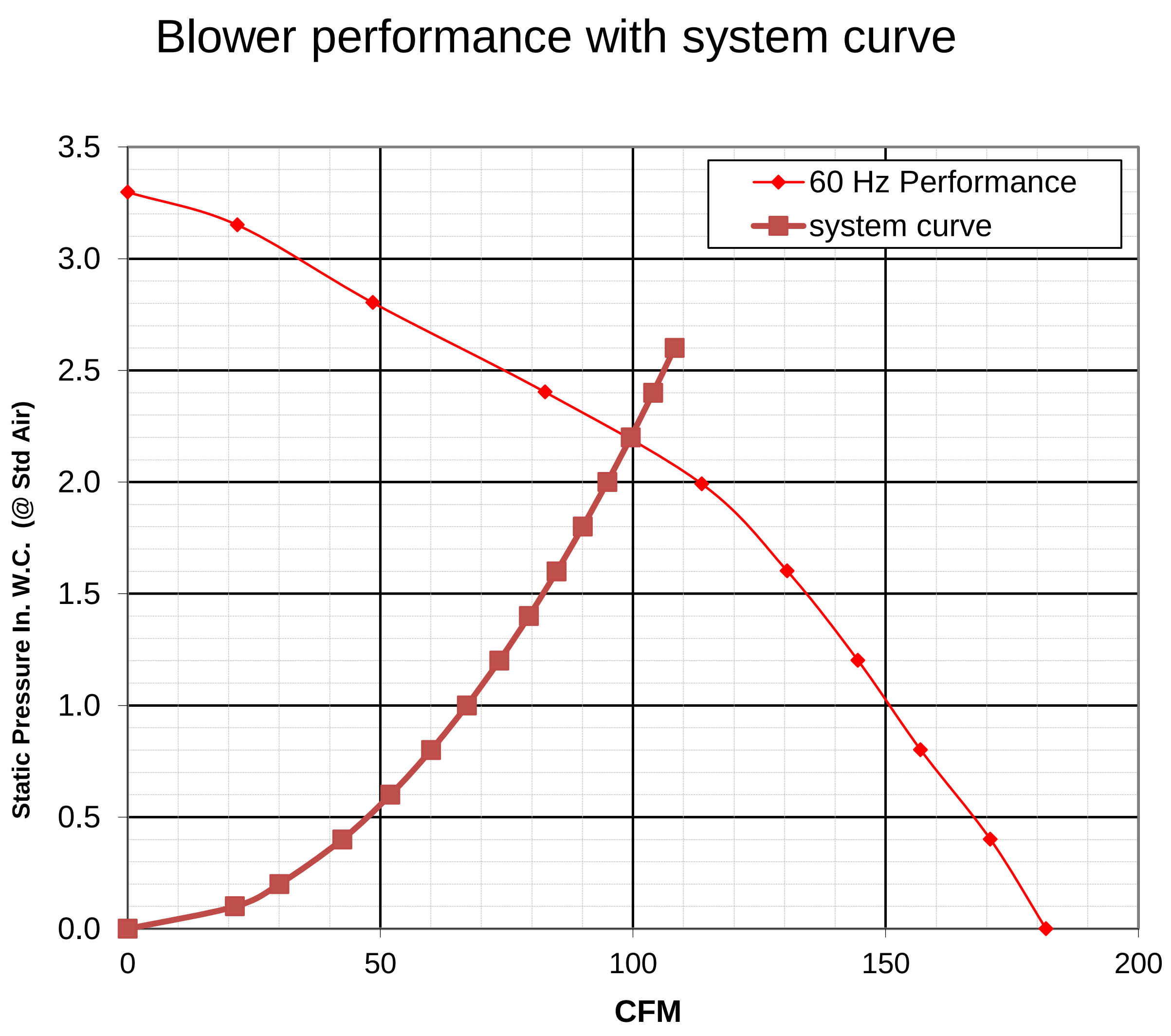
- New Blower speed = 3100 RPM; New CFM = 24.4
- New CO_2 = 8.3%
- New Static Pressure = 1.88 In W.C.

Change frequency - Effect on Appliance

- Examples using fan laws and Combustion Calculator – Change frequency 60 to 50hz

- Heater Firing Rate = 400kBtu/Hr; Heating Value = 1020 Btu/FT3; CO_2 = 8.3%
- Total Combustion Air Flow = 100 CFM; Static Pressure = 2.7
- Blower speed - 3450RPM @ 60Hz with 4.3% slip

Change frequency - Effect on Appliance

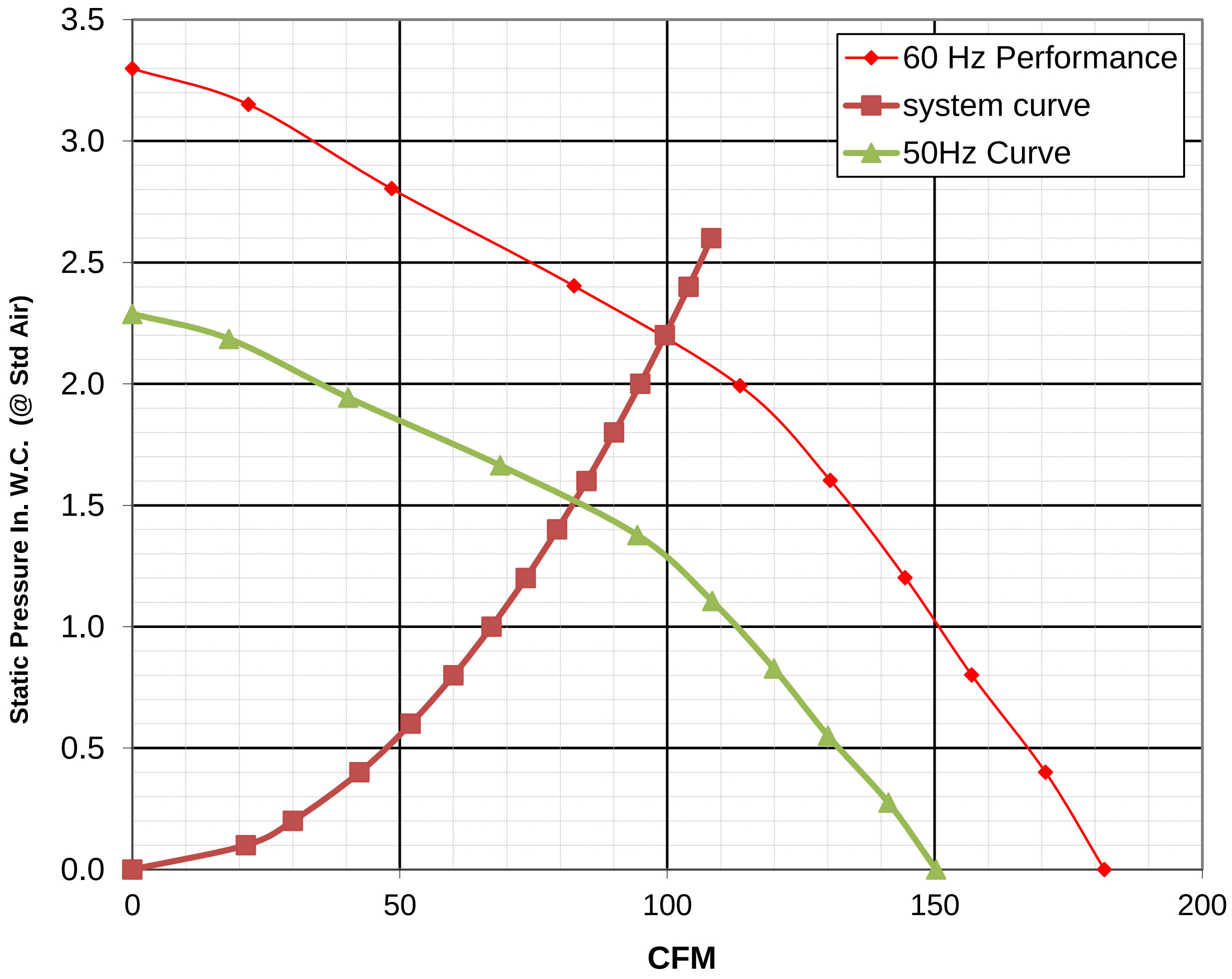


Change frequency - Effect on Appliance

- Original Blower – 100CFM 2.2 Static press 3450 RPM 60Hz 4.3% slip
- Change to 50Hz on the same blower.
- 50 Hz speed= (3000 X .957) = 2871 RPM
- New CFM = 100 X 2871/3450 = 83.2 CFM
- New Blower pressure is 1.52 from system curve
- New Blower Pressure
  - Fan Law = 2.2 X ((2871/3450)^2) = 1.52

- New Firing Rate at the same CO_2 – using combustion calculator = 334,240 Btu/hr

Change frequency - Effect on Appliance



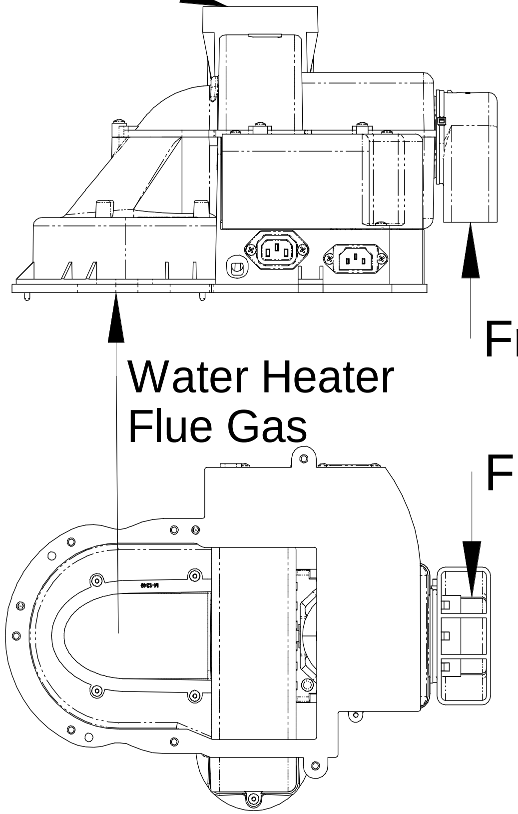
Altitude - Effect on Appliance

- Speed varies inversely as the density ratio.
- Air Flow varies inversely as the density ratio.
- Pressure varies inversely as the density ratio
- Air density at sea level = .0748 lbs/ft3 29.92In.Hg 70F
  - Speed = 3300; Pressure = 1.00
  - Air flow =100
- At Cassville with Air density = .0712lbs/ft3 29.92In.Hg 70F
  - Speed = 3467; Pressure = 1.050
  - Air flow = 105

Dilution Air Blower – Power Vent Water Heaters

Exhaust

Room Air or outside on
direct vent



Fresh Air Inlet

Water Heater
Flue Gas

Fresh Air Inlet

Dilution Air Blower – Power Vent Water Heaters

Calculate Air Flow Requirements

- Air from Heater Flue – Measure CO_2 in flue
- Total Air Flow – Measure CO_2 in exhaust
- Dilution Air = (Flue – Total)

Example

- Air from Heater
  - CO_2 in Flue = 8%; HV = 1020; Firing rate = 52,000 Btu/Hr; CO_2 in Exhaust = 2.0%
  - Combustion Air Flow = 13.4 CFM
  - Total Air Flow = 48.4 CFM
  - Dilution Air Flow = 35.0 CFM

Dilution Air Blower – Power Vent Water Heaters

Example - lower the CO_2% from 8.0 to 7.2%

Add restriction to the air intake to the blower (reduce dilution air)

- Readings from Heater
  - CO2 in Flue = 7.2%; HV = 1020; Firing rate = 52,000 Btu/Hr;
    - Dilution air is reduced and flue air is increased, so that the total CFM and CO2 in Exhaust maintain = 2.0%
  - Combustion Air Flow = 14.7 CFM increased by 1.3 CFM
  - Total Air Flow = 48.4 CFM
  - Dilution Air Flow = 33.7 CFM decrease by 1.3 CFM

ASGE Technical Conference – detail outline

- Premix
  - How to determine air flow requirement
    - Review formula
    - Show examples
  - System curves
    - Review formula
    - Determine flow and pressure point on wind tunnel curve
    - Add system curve to wind tunnel curve
  - Turn down
    - Show wind tunnel curve at 100% - 20% PWM
    - Calculate system curve and graph

Determine air flow requirements

Combustion air flow = (air flow at 10:1 + excess air + gas flow) Ft^3/Min

Text has 9.7:1 Air to gas ratio

Examples:

Firing rate = 800kBtu/hr, Heating Value = 1030 Btu/Ft3; CO2 = 8.05

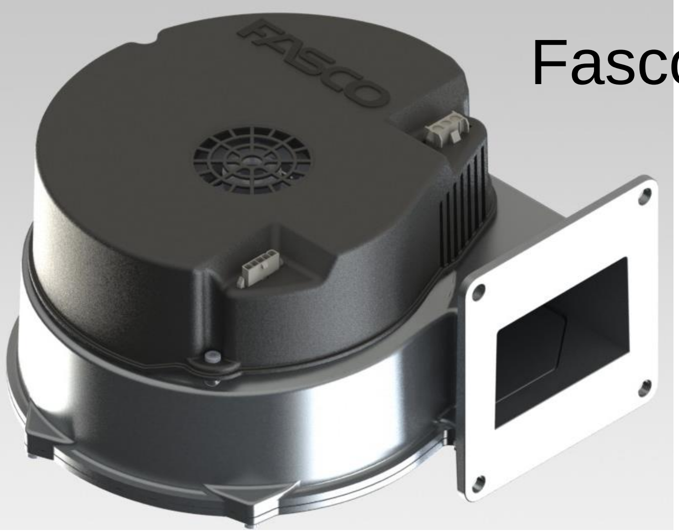
Total CFM = 200

Firing rate = 1,185kBtu/hr, Heating Value = 1030 Btu/Ft3; CO2 = 9.5

Total CFM = 300

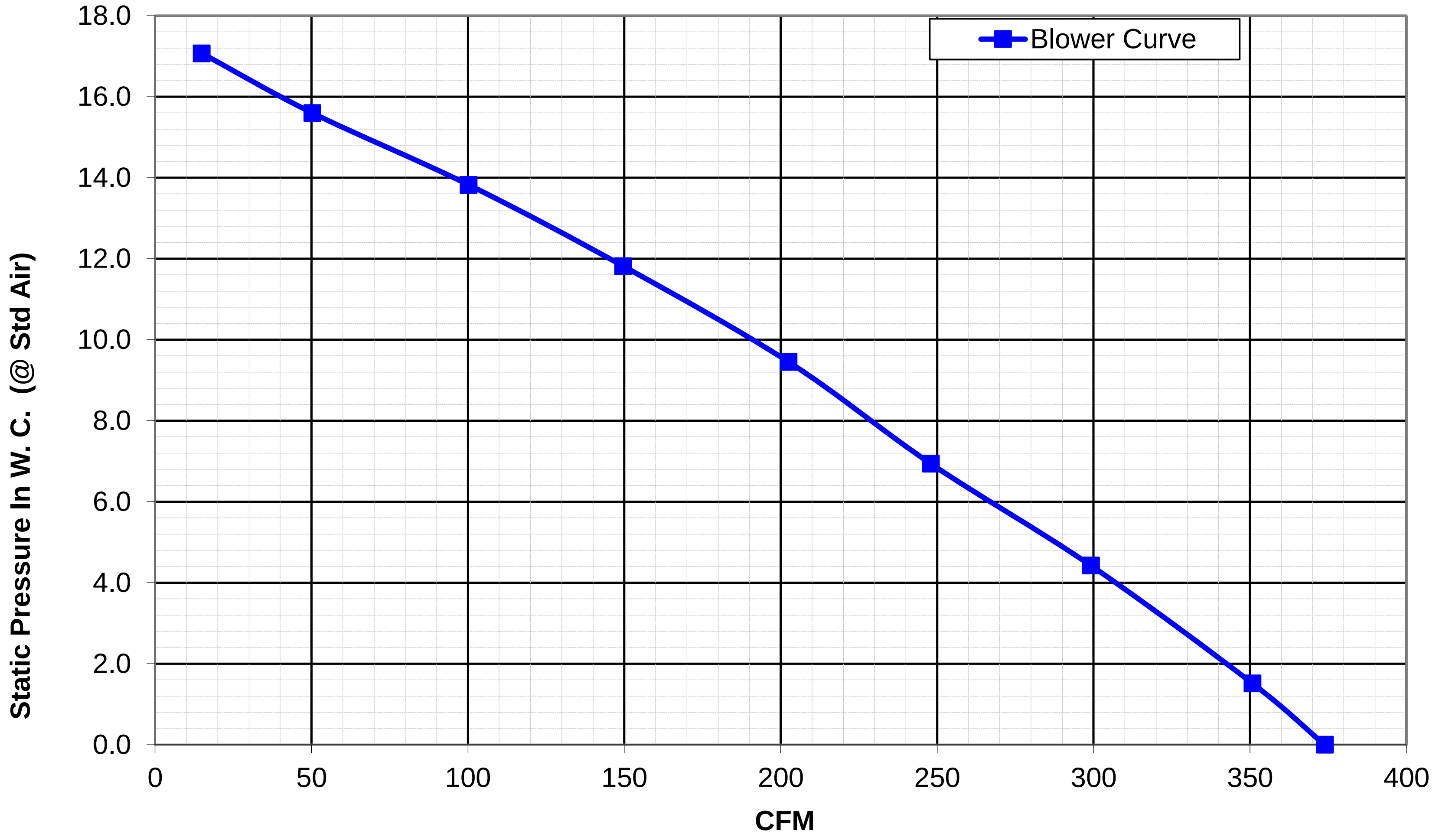
Determine system curve

- System curve CFM = SQRT (static press/(air density X k factor)
- K Factor = Static Press/(air density X Air Flow ^2)
- Pick the point the wind tunnel curve at the combustion flow desired to find blower static pressure
- Calculate system curve from 0 to pressure at combustion flow pt.
- Example blower

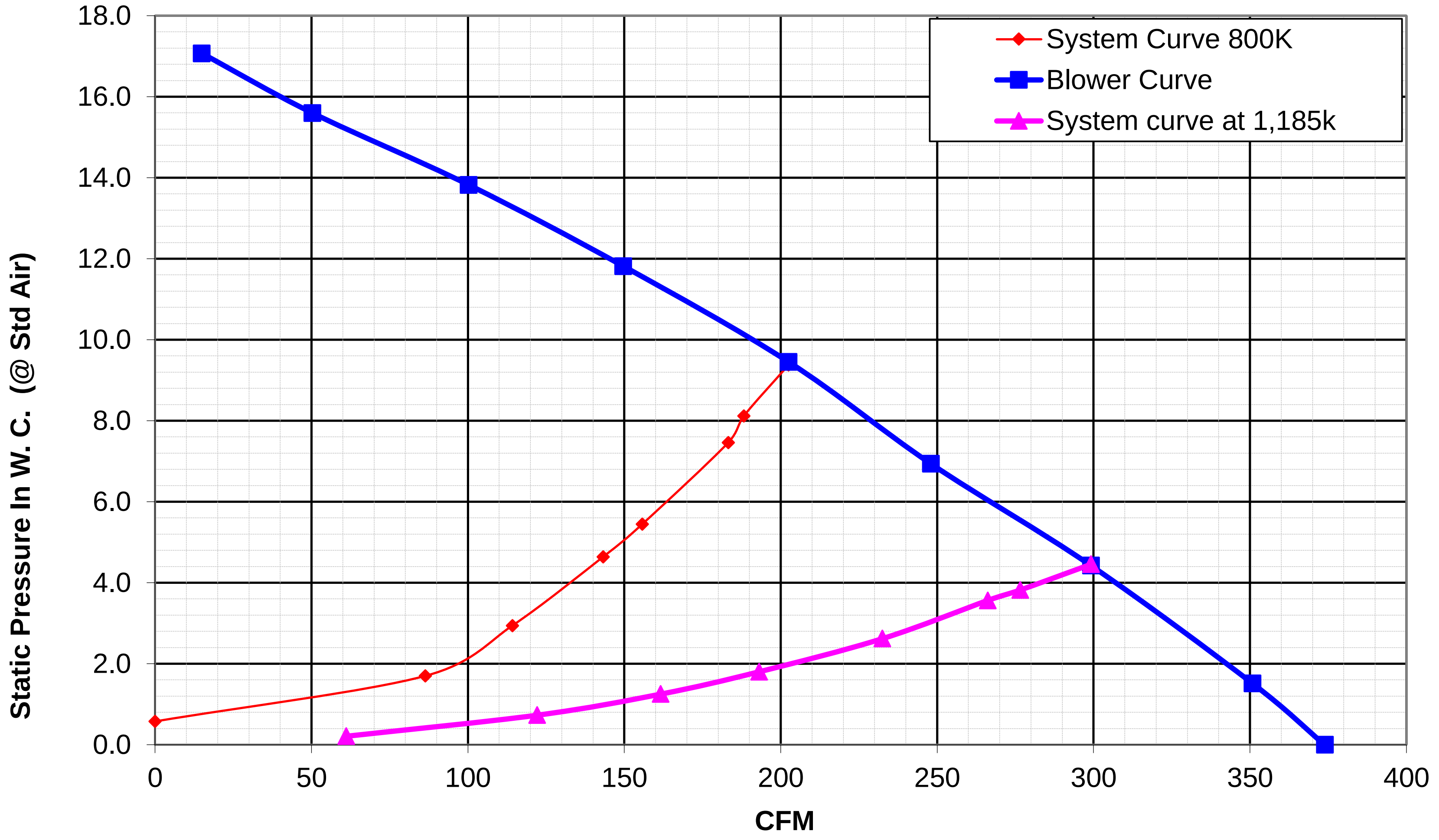


Fasco 7.0

Blower Curve with Gas Venturi



Blower Curve with System Curve From Test



Note: Blower tested with Gas Venturi

System Curve Calculated vs Wind Tunnel