Use of Eductor for Lifting Water

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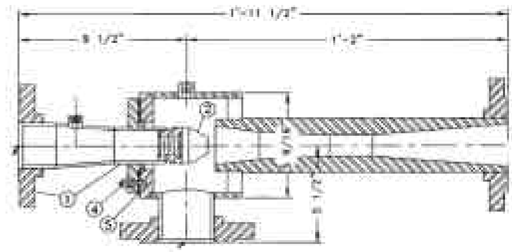
Overview

- Eductor theory
- Case studies
- Equipment configuration

Eductor Theory



- From the family of thermocompressors that includes Air Ejectors, Evacuators, Sand Blasters, Jet Pumps, and Eductors
- High pressure gas entrains and compresses suction gas and the combined stream is left at an intermediate pressure
- Compression rations 1.3-2.0 are possible, limited by:
  - Power gas pressure
  - Suction pressure
  - Discharge pressure

Eductor Example

- P_{atm}=12 psia
- Gas is Methane
- m°_{power}=600 lb/hr
- m°_{suct}=300 lb/hr
- P_{pwr}=100 psig
- T_{pwr}=80°F
- P_{disc}=21 psig
- R=1.5
- Find
  - $P_{suction}$, q_{power}, $q_{suction}$

$$?_{power} = \frac{MW*P}{10.73*T*Z} = \frac{(16)*112\,psia}{10.73*(460+80)*.97} = 0.319\frac{lbm}{ft^3}$$

$$q_{pwr} = \frac{\dot{m}_{pwr}}{?_{pwr}} = \frac{600\,lbm/hr}{0.319\,lbm/ft^3}\left(\frac{112*520*0.98}{14.73*540*0.97}\right)\frac{24}{1000} = 333\,MCF/d$$

$$P_{suction} = \frac{P_{disch}}{R} = \frac{(21\,psig+12\,psi)}{1.5} = 22\,psia$$

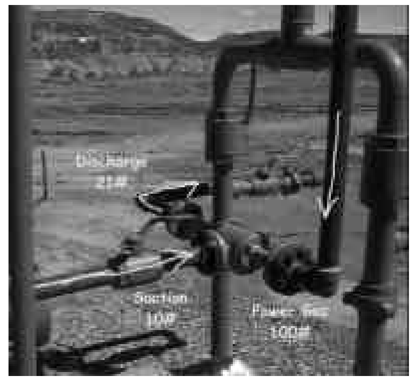
$$r_{suct} = \frac{16*22}{10.73*(460+60)*.98} = 0.064\frac{lbm}{ft^3}$$

$$q_{suct} = \frac{300\,lbm/hr}{0.064\,lbm/ft^3}\left(\frac{22*520*.98*24}{14.73*520*.98*1000}\right) = 168\,MCF/day$$

At 10 psig, 60°F, and 168 MCF/d you can Move 0.75 bbl/day up 3,000 ft of 2-3/8 tubing

Eductor Theory

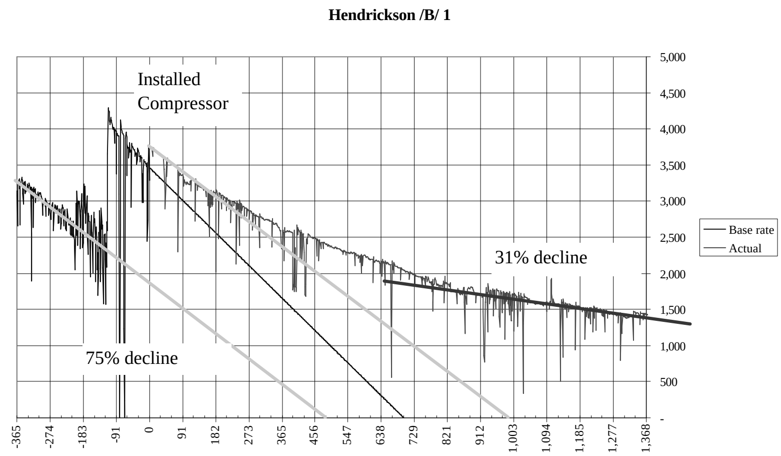
- Small amount of hp
  - 16 hp for power gas
  - 7.4 hp used in eductor
  - ε=46%
- Slow to react (can take 2-3 weeks or longer to stabilize water level)
- Pretty effective in maintenance mode



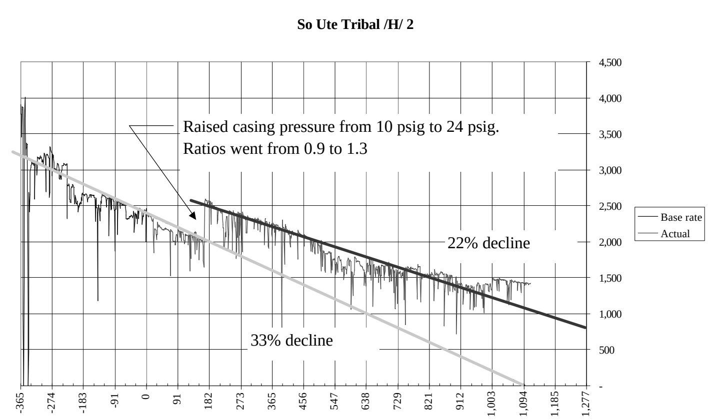
Eductor Rules of Thumb

- For an eductor with gas as the power fluid:
  - Exhaust pressure should be less than ½ power-gas pressure (in absolute terms)
  - Exhaust pressure should be less than twice suction pressure
  - Mass flow rate of power gas will be about twice suction mass flow rate.
- With liquid as the power fluid:
  - You don't get to critical flow so the exhaust pressure can be higher
  - More "compression ratios" are possible (i.e., the ratio of the exhaust over the suction can be more than 2)
- If the power gas is a mixture of gas and liquid, calculate the density and the mass flow rate carefully

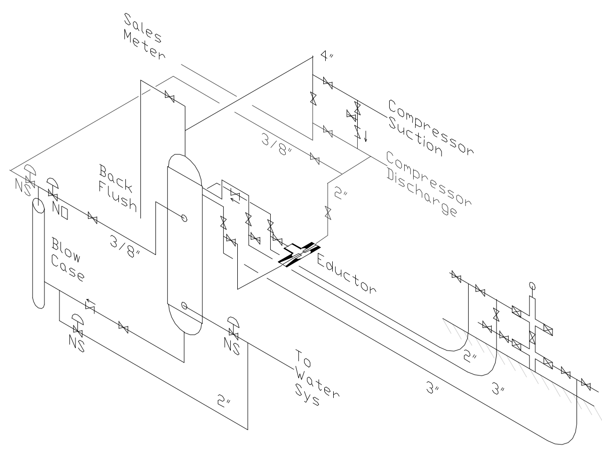
Case Studies



Case Studies



Equipment Configuration



Equipment Configuration

- Must have
  - At least two lines from wellhead to separator
  - Check valve on tubing line between eductor and separator
  - Compressor with at least 50 psig discharge and 20 Hp extra
  - Patience (it can take 2-3 weeks before you see results)
- Good to have
  - Block valve between eductor and check with blow down on check side of block
  - Two inlet nozzles on separator (without this, you must be very careful how you bring the two lines together)

Screening Criteria for Other Applications

- Need a source of gas pressure at least twice (in psia) the exhaust pressure.
- Need an application where 1.5-2.0 ratios does some good.
- Example:
  - You have a well with 500 psig upstream of a choke, line pressure is 150 psig

    $$\frac{500+12}{2}-12=244\,psig>150\,psig--OK$$

  - A nearby well would flow better at 75 psig line pressure

    $$\frac{150+12}{75+12}=1.86\,ratios--OK$$

  - Can you use the energy you're loosing across the choke to drive an eductor to pull on the nearby well? Possibly, need to check rates

Other Possibilities