Artificial Lift

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Lecture-62 Surface Compressor for Gas Lift - Part 3

Adiabatic, isothermal, and polytrophic curves for reciprocating compressors. We've illustrated these as 1, 2, 3, 4. I've mentioned that it would look like this for an isothermal system. If you have PV for pV equals a constant, this is pV power gamma equals a constant, whereas this is pV power n. I'm using 'n' for polytrophic, pV power n equals a constant. Ideally, our goal should be to reach this curve, but practically it's not possible, so we follow pV power n.

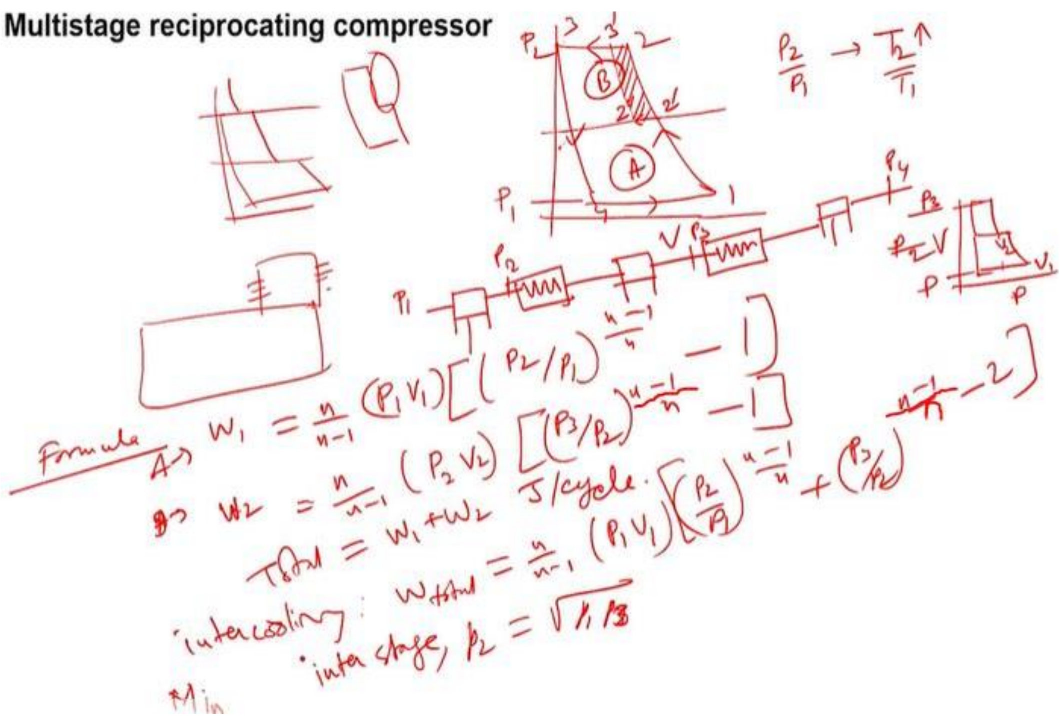
When talking about a multistage compressor, a multistage compressor looks like this. If you are compressing using a single stage, it involves p1, p2, and so on. Due to the high pressure ratio, your temperature will be very high, with a temperature rise of T2 by T1 being significant. To tackle this issue, you create multiple staging, with each stage consisting of a piston-cylinder arrangement. For instance, you might have p1, p2, followed by a heat exchanger, then another piston-cylinder arrangement, and so on. Then, after p3 and p4, you achieve the desired pressure. You use multiple pistons instead of raising the pressure from p1 to p4 in one go. After each piston, you reduce the pressure ratio, cool down, and reduce the temperature, and then put it into the second cylinder, reduce the temperature again, and so on through third and fourth cylinders. In this way, you create multiple stages, and at every stage, you remove heat, thus increasing the system's performance.

Now, we've depicted the single-stage compression in this figure. However, if we use multiple staging, we follow the same philosophy. In a multistage setup, you break the process into stages. For instance, you have the first stage as A to B, and after the first stage, you reduce the temperature, which decreases the volume (from 1 to 2 dash). You then use this low-volume fluid or air in the second stage, further compressing it. You reach stage 3 dash, and so on.

As you move to the left side, you save some work. In the indicator diagram, the area covered by 1, 2, 3, and 4 represents the work done. With multiple stages, you save some of this energy. This is the beauty of multistaging.

In any cycle shop with a compression system, you can observe a cylinder and some machine elements, typically with fins. Fins are used to reduce the temperature, so the overall system's performance improves.

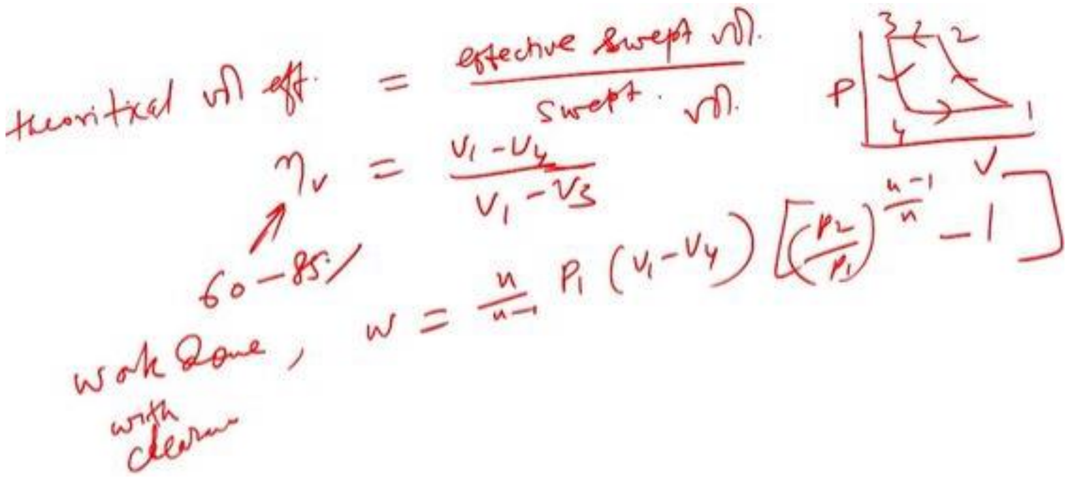
Now, let's discuss the formulation. There are several formulas available for theoretical volume flow efficiency and theoretical dynamic efficiency, which are calculated based on volume parameters. Typically, the volume efficiency ranges from 60 to 85 percent.



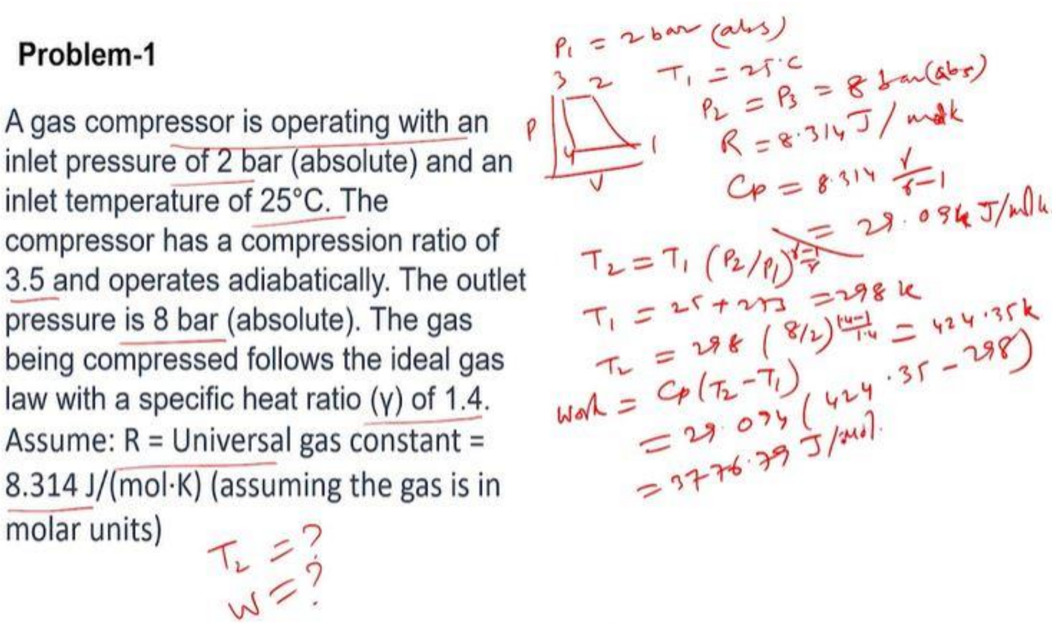
Now, let's move on to a problem involving a gas compressor operating with an inlet pressure of 2 bar absolute and an inlet temperature of 25 degrees Celsius. The compressor has a compression ratio of 3.5, and the outlet pressure is 8 bar. The gas follows the ideal gas law, and the heat ratio is given along with the value of R.

To calculate various parameters, such as T2 and work done, we start by using P1 (given as 2 bar), and we draw a PV diagram. Similarly, P2 is given as 8 bar, R is 8.314 J per mole per Kelvin, and Cp can be calculated as 29.094 J per mole K.

Work is calculated with the formula W equals Cp * (T2 minus T1), which gives us a value of 37776.79 J per mole.

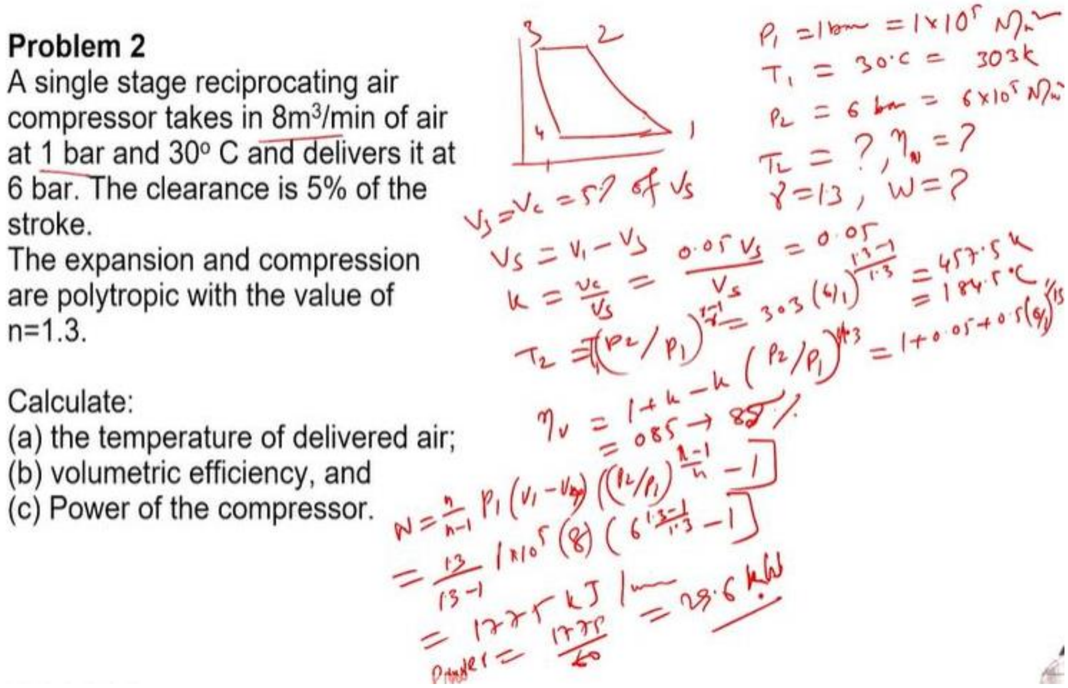


In another problem, a single-stage reciprocating air compressor is given with an air volume of 8 cubic meters, an inlet pressure of 1 bar, and an inlet temperature of 30 degrees Celsius. The outlet pressure is 6 bar, and parameters like volumetric efficiency (ηV), γ, and work done need to be calculated.



To compute the volumetric efficiency, we use the formula ηV equals 1 plus K minus K * (P2 / P1), which results in an ηV of 0.85 or 85 percent.

Work done is calculated using the formula W equals [N / (N minus 1)] * P1 * (V1 minus V4) * (P2 / P1)^(N minus 1 / N), which gives a value of 1775 kJ. The power is calculated as 29.6 kilowatts for this problem.



Now, this is the last lecture for this artificial lift course. You have learned how oil and gas are formed, how multiphase flow occurs, and what the different formulas are for multicomponent fluids. You've also learned about the IPR relationship. After that, you learned about various pumping systems, different artificial lift mechanisms, and individual artificial lifts such as SRP, ESP, PCP, gas lift, hydraulic lift, and surface pump compressors. Furthermore, you learned about plunger lifts and gained insights into electrical, mechanical, and fluid mechanics related to these systems.

To gain more from this course, you should consider doing some additional study. There are many videos available on YouTube related to each topic. For example, there are hundreds of videos and photos related to SRP research on the internet. You can also find several lectures from different universities, enthusiasts, industry experts, or field demonstrations. Please take the time to explore these videos and utilize resources like Wikipedia and chat with GPT. There are numerous ways to learn and expand your knowledge.

If you're a student searching for a job or already working in the industry and aiming for career enhancement or promotion, remember that continuous learning is key. Learning can open up more opportunities in your career and job.

I have already discussed the selection criteria in individual lectures regarding the selection of artificial lift methods. However, if I were to summarize, each method has its own advantages and disadvantages. For instance, sucker rod pumps (SRP) are a heavy surface unit, which may limit their use in offshore applications and for high flow rates. SRPs may face gas lock or fluid pounding challenges when very high gas content is present. On the other hand, SRPs work well for low flow rate applications and gas well de-gluing purification.

Electric submersible pumps (ESP) are suitable for higher flow rates and can be used in horizontal, vertical, or slant wellbores. However, ESPs may face challenges such as cavitation, electrical connections, and motor protection issues.

Progressing cavity pumps (PCP) have the advantage of handling heavy and thick fluids but tend to have a relatively shorter operational life, typically around 5 to 6 months. In situations where heavy fluids are involved, PCPs are a valuable choice.

Gas lift systems are versatile and can be used to optimize production by reducing flowing pressure. This, in turn, allows for increased fluid inflow into the wellbore, resulting in higher production.

Hydraulic systems, particularly jet pumps, are known for their long life but exhibit low efficiency. Despite this, they are still in use due to their durability. Hydraulic engine pumps have an additional engine system in the wellbore, similar to sucker rod pumps, which requires careful operation when in use.

When selecting any type of artificial lift, it's crucial first to understand the various options and their limitations. Blindly choosing an artificial lift method can decrease productivity and unnecessary costs after installation. Studying the different artificial lifting techniques available is essential, evaluating the criteria, and carefully assessing your specific wellbore conditions is essential. By doing so, you can decide on the most suitable artificial lift method for your well.

Some advanced techniques that I didn't include here involve multi-criteria decision-making options. Multi-criteria decision-making takes into account various criteria for different artificial lift methods. For instance, you can use SRP for criteria like high pressure, high volume, low pressure, or low volume, and you can apply similar criteria to ESP. By creating a matrix with "yes" or "no" decisions based on these criteria and weighting the options, you can ultimately converge on 1 or 2 artificial lift methods that best suit your wellbore or group of wellbores.

Numerous software tools are available for artificial lift selection, but it's essential to have a solid understanding of the different artificial lifting mechanisms, addressing mechanical, fluid mechanics, and electrical issues before using any software for selection.

Wishing you the best of luck, I hope you've learned a lot from this course. Whether you're job hunting or looking to enhance your career in the industry, this knowledge will undoubtedly be valuable. Thank you very much for listening. Stay happy, stay beautiful, and thank you again. Goodbye, and thank you.