وزارة التعليم العالي والبحث العلمي
الجامعة التقنية الشمالية
المعهد التقني كركوك

الحقيبة التعليمية

القسم العلمي: ميكانيك القدرة/ التبريد والتكييف

اسم المقرر: ديناميك الحرارة التطبيقي

المرحلة / المستوى: الاول

الفصل الدراسي: الثاني

السنة الدراسية:2025/2024

معلومات عامة

اسم المقرر:	ديناميك الحرارة التطبيقي					
القسم:	ميكانيك القدرة/ التبريد والتكييف					
المعهد:	المعهد التقني كركوك					
المرحلة / المستوى	الاول					
الفصل الدراسي:	الثاني					
عدد الساعات الاسبوعية:	نظري	ساعتان	عملي	ساعتان		
عدد الوحدات الدراسية:	4					
الرمز:	PMTR139					
نوع المادة	نظري		عملي		كلهما	√
هل يتوفر نظير للمقرر في الاقسام الاخرى	/					
اسم المقرر النظير	/					
القسم	/					
رمز المقرر النظير	/					

معلومات تدريسي المادة

اسم مدرس (مدرسي) المقرر:	مرال محمود حسين	محمود حسين خليل
اللقب العلمي:	مدرس مساعد	مدرس
سنة الحصول على اللقب	2021	2021
الشهادة :	ماجستير	ماجستير
سنة الحصول على الشهادة	2021	2014
عدد سنوات الخبرة (تدريس)	15	10

الوصف العام للمقرر

مقرر ديناميك الحرارة يتناول دراسة الخواص الحرارية للمواد، والقوانين الأساسية للديناميكا الحرارية، مع التركيز على تطبيقها في تصميم وتشغيل أنظمة التبريد والتكييف لتحسين الكفاءة الحرارية.

الاهداف العامة

- إكساب الطلاب الفهم الأساسي للقوانين الحرارية.
- تمكين الطلاب من تطبيق النظريات الحرارية على الأنظمة الهندسية.
- تطوير القدرة على تحليل العمليات الحرارية في أنظمة التبريد والتكييف.

الأهداف الخاصة

- فهم وتحليل الدورة الحرارية لأنظمة التبريد والتكييف.
- استيعاب كيفية حساب الكفاءة الحرارية للآلات والأجهزة.
- تطبيق القوانين الأساسية للطاقة والحرارة في مواقف عملية.
- التعرف على خواص المواد المستخدمة في أنظمة التبريد والتدفئة.
- تطوير المهارات اللازمة لحل المسائل المتعلقة بالطاقة والحرارة في الأنظمة الهندسية.

الأهداف السلوكية او نواتج التعلم

- استخدام المفاهيم الأساسية: يتمكن الطالب من تعريف وتطبيق المفاهيم الأساسية للثرموديناميك مثل الطاقة، الحرارة، والعمل في سياقات عملية.
- حل المشكلات: يتقن الطالب مهارات حل المشكلات المتعلقة بالدورات الحرارية، وتحليل العمليات في أنظمة التبريد والتدفئة.
- تحليل الأنظمة: يكون الطالب قادراً على تحليل كفاءة الأنظمة الحرارية المختلفة مثل المحركات، والمبادلات الحرارية، والضواغط.
- استخدام الجداول والرسوم البيانية: يستطيع الطالب قراءة واستخدام جداول البخار والرسوم البيانية مثل مخطط (P-V) و(T-S) لتحليل العمليات الثرموديناميكية.
- التفكير النقدي: يطور الطالب القدرة على نقد وتقييم أداء الأنظمة الحرارية وتحسين كفاءتها.

المتطلبات السابقة

- مقدمة في الفيزياء: فهم أساسي لمفاهيم الفيزياء، بما في ذلك القوى، والحركة، والطاقة.
- مقدمة في الرياضيات: القدرة على استخدام الرياضيات لحل المعادلات الرياضية الأساسية، بما في ذلك التفاضل والتكامل.
- مقدمة في الكيمياء: معرفة بالمفاهيم الأساسية في الكيمياء، وخاصة المتعلقة بالحرارة والتفاعلات الكيميائية.
- المبادئ الأساسية في الهندسة: فهم مبادئ الهندسة الأساسية، مثل الديناميكا السائلة والمواد الهندسية.
- مقدمة في الميكانيكا: فهم الأساسيات المتعلقة بالميكانيكا والكفاءة الديناميكية.

الأهداف السلوكية او مخرجات التعليم الأساسية		
ت	تفصيل الهدف السلوكي او مخرج التعليم	آلية التقييم
1	يتم تقييم فهم الطلاب للمفاهيم من خلال الاختبارات الكتابية التقليدية.	الاختبارات الكتابية
2	يتم تقييم القدرة على تطبيق المعرفة الرياضية في حل المشكلات.	الواجبات المنزلية
3	يتم تقييم القدرة على تطبيق المعرفة في سياقات العالم الحقيقي.	المشاريع
4	يتم تقييم القدرة على التواصل الفعال للأفكار والمفاهيم .	المشاركة في الصف
5	يتم استخدام الأدوات والبرامج الرقمية لتقييم فهم الطلاب للمفاهيم	الاختبارات الإلكترونية

أساليب التدريس

الاسلوب او الطريقة	مبررات الاختيار
1. المحاضرات	تقديم المعلومات والمفاهيم الرياضية بشكل مباشر للطلاب
2. التعلم النشط	تشجيع الطلاب على المشاركة في عملية التعلم من خلال حل المشكلات، المناقشات الجماعية، والأنشطة التفاعلية
3. التعلم القائم على المشروع	يتم تكليف الطلاب بمشاريع تتطلب تطبيق المعرفة الرياضية في سياقات العالم الحقيقي
4. التعلم الذاتي	يتم تشجيع الطلاب على البحث والاستكشاف بشكل مستقل لتعزيز فهمهم للمفاهيم الرياضية
5. التعلم الرقمي	استخدام الأدوات والبرامج الرقمية لتعزيز التعلم والفهم
6. التقييم المستمر	يتم تقييم الطلاب بشكل مستمر من خلال الاختبارات، الواجبات، والمشاريع

الفصل الاول من المحتوى العلمي							
عنوان الفصل	الوقت		المصفوفات				
التوزيع الزمني	النظري (ساعة)	العملي	العنوان الرئيسي		طريقة التدريس	التقنيات	طرق القياس
الأسبوع				العناوين الفرعية	محاضرة حضوري او الكتروني	عرض تقديمي، شرح، أسئلة وأجوبة, مناقشة	
الأسبوع السادس عشر+ السابع عشر	2	2	Carnot Power Cycle and Reversed Carnot Cycle,	• Carnot Power Cycle, • Reversed Carnot Cycle, • Applications of the Carnot Cycle,	حضوري	عرض تقديمي+ شرح	الامتحان اليومي
الأسبوع الثامن عشر+ التاسع عشر	2	2	Study of Steam and Steam Properties – Using Steam Tables,	• Definitions and Key Concepts, • Steam Tables, • Examples of Using Steam Tables, • Applications of Steam,	حضوري	عرض تقديمي + شرح + أسئلة وأجوبة + مناقشة	الامتحان اليومي
الاسبوع العشرون	2	2	Calculations of the Properties for Liquid-Vapor Mixture (Wet Steam),	• Definitions and Key Concepts, • Detailed Calculations for Wet, • Steam Properties, • Practical Applications of Wet Steam, • Applications of Steam,	حضوري	عرض تقديمي+ شرح+ أسئلة وأجوبة+ مناقشة	الامتحان اليومي

الفصل الثالث من المحتوى العلمي							
عنوان الفصل	الوقت		المصفوفات				
التوزيع الزمني	النظري (ساعة)	العملي	العنوان الرئيسي		طريقة التدريس	التقنيات	طرق القياس
الأسبوع				العناوين الفرعية	محاضرة حضوري او الكتروني	عرض تقديمي، شرح، أسئلة وأجوبة, مناقشة	
الأسبوع الحادي والعشرون+ الثاني والعشرون	2	2	Steam Processes at Constant Pressure, Volume - Isentropic Process, Adiabatic Process & Applications,	• Definitions and Key Concepts, • Detailed Calculations for Isentropic and Adiabatic Processes, • Applications in Refrigeration and Air Conditioning,	حضوري	عرض تقديمي+ شرح	الامتحان اليومي
الأسبوع الثالث والعشرون+ الرابع والعشرون	2	2	The Rankine Cycle - Processes, Examples,	• Processes of the Rankine Cycle, • Rankine Cycle Efficiency, • Applications of the Rankine Cycle,	حضوري	عرض تقديمي + شرح + أسئلة وأجوبة + مناقشة	الامتحان اليومي
الاسبوع الخامس والعشرون	2	2	The Vapor Compression Cycle - Processes, Examples, and Applications,	• Introduction to the Vapor Compression Cycle, • Processes of the Vapor Compression Cycle,	حضوري	عرض تقديمي+ شرح+ أسئلة وأجوبة+ مناقشة	الامتحان اليومي

الفصل الثاني من المحتوى العلمي

عنوان الفصل	الوقت		المصفوفات				
التوزيع الزمني	النظري (ساعة)	العملي	العنوان الرئيسي		طريقة التدريس	التقنيات	طرق القياس
الأسبوع				العناوين الفرعية	محاضرة حضوري او الكتروني	عرض تقديمي، شرح، أسئلة وأجوبة, مناقشة	
الأسبوع السادس والعشرون+ السابع والعشرون+ الثامن والعشرون	2	2	Fuel - Definitions, Properties, and Applications in Boilers and Cooling Systems,	• Introduction to Fuel, • Properties of Fuel, • Applications of Fuel in Boilers,	حضوري	عرض تقديمي+ شرح	الامتحان اليومي
الأسبوع التاسع والعشرون+ الثلاثون	2	2	Boilers - Types and Characteristics,	• Introduction to Boilers, • Types of Boilers, • Characteristics of Boilers,	حضوري	عرض تقديمي + شرح + أسئلة وأجوبة + مناقشة	الامتحان اليومي

المحتوى العلمي

خارطة القياس المعتمدة

المحتوى التعليمي	عناوين الفصول	الأهمية النسبية	الأهداف السلوكية					عدد الفقرات
			المعرفة	الفهم	التطبيق	التحليل	التقييم	
			النسبة %20	%20	%20	%20	%20	
الفصل الاول	Carnot Power Cycle and Reversed Carnot Cycle, Study of Steam and Steam Properties – Using Steam Tables, Calculations of the Properties for Liquid-Vapor Mixture (Wet Steam),	%40	8	8	8	8	8	4
الفصل الثاني	Steam Processes at Constant Pressure, Volume - Isentropic Process, Adiabatic Process & Applications, The Rankine Cycle - Processes, Examples, The Vapor Compression Cycle - Processes, Examples, and Applications,	%35	7	7	7	7	7	4
الفصل الثالث	Fuel - Definitions, Properties, and Applications in Boilers and Cooling Systems, Boilers - Types and Characteristics,	%25	5	5	5	5	5	5
المجموع		100 %	20	20	20	20	20	**13**

Week No.	Details
16-17	Carnot Power Cycle and Reversed Carnot Cycle,
18-19	Study of Steam and Steam Properties – Using Steam Tables,
20	Calculations of the Properties for Liquid-Vapor Mixture (Wet Steam),
21-22	Steam Processes at Constant Pressure, Volume - Isentropic Process, Adiabatic Process & Applications,
23-24	The Rankine Cycle - Processes, Examples,
25	The Vapor Compression Cycle - Processes, Examples, and Applications,
26-27-28	Fuel - Definitions, Properties, and Applications in Boilers and Cooling Systems,
29-30	Boilers - Types and Characteristics,

الفصل الاول: رقم المحاضرة: 20+19+18+17	
عنوان المحاضرات:	دورة كارنوت ودورة كارنوت المعكوسة، دراسة خصائص البخار – استخدام جداول البخار، حسابات خواص خليط البخار السائل (البخار الرطب)،
اسـم المدرسين:	م.م. مرال محمود حسين و م. محمود حسين خليل
الفئة المستهدفة :	المرحلة الاولى/ المعهد التقني
الهدف العام من المحاضرة :	تزويد الطلاب بالمعرفة والفهم والتطبيق والتحليل والتقويم في علم ديناميك الحرارة ودورة كارنوت ودورة كارنوت المعكوسة، دراسة خصائص البخار استخدام جداول البخار، حسابات خواص خليط البخار السائل (البخار الرطب)،
الأهداف السلوكية او مخرجات التعلم:	1 - يتم تقييم فهم الطلاب للمفاهيم الثرموديناميكية من خلال الاختبارات الكتابية التقليدية. 2 - يتم تقييم القدرة على التطبيق في حل المشكلات. 3 - يتم تقييم القدرة على تطبيق المعرفة الرياضية في سياقات العالم الحقيقي. 4- يتم تقييم القدرة على التواصل الفعال للأفكار والمفاهيم الرياضية والمعرفية.
استراتيجيات التيسير المستخدمة	1. المحاضرات 2. التعلم النشط 3. التعلم القائم على المشروع 4. التعلم الذاتي 5. التعلم الرقمي 6. التقييم المستمر
المهارات المكتسبة	سيكون لدى الطالب قابلية التطوير والقدرة على التفكير المنطقي والتحليلي والنقدي في حل المشكلات التخصصية في الجانب الحراري والرياضي والهندسي.
طرق القياس المعتمدة	الامتحانات اليومية والشهرية و تكليف الطلاب بمشاريع تتطلب تطبيق المعرفة

The Sixteenth and Seventeenth Lecture

(Carnot Power Cycle and Reversed Carnot Cycle)

Pre-Lecture Questions:

1. What is the Carnot cycle, and why is it important in thermodynamics?
2. How does the reversed Carnot cycle function in refrigeration and heat pump applications?
3. What factors affect the efficiency of the Carnot cycle?

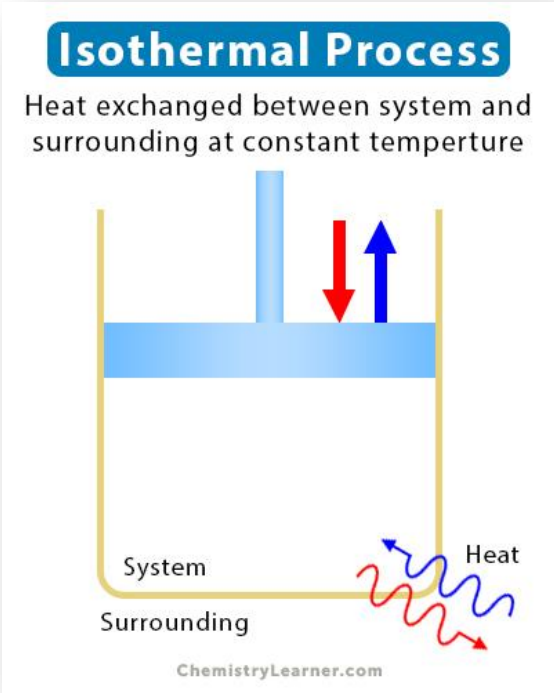
Carnot Power Cycle

A. Definition

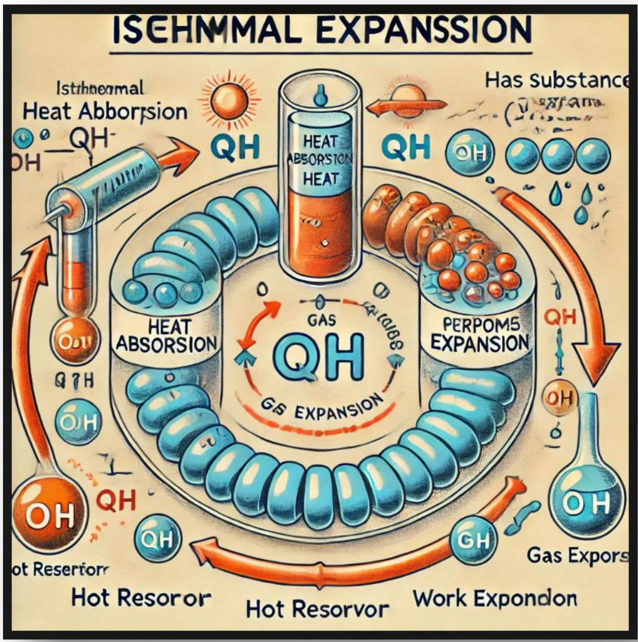
- **Carnot Cycle:** A theoretical thermodynamic cycle that provides the maximum efficiency possible for a heat engine operating between two temperature reservoirs.

B. Components of the Carnot Cycle

The Carnot cycle consists of four reversible processes:

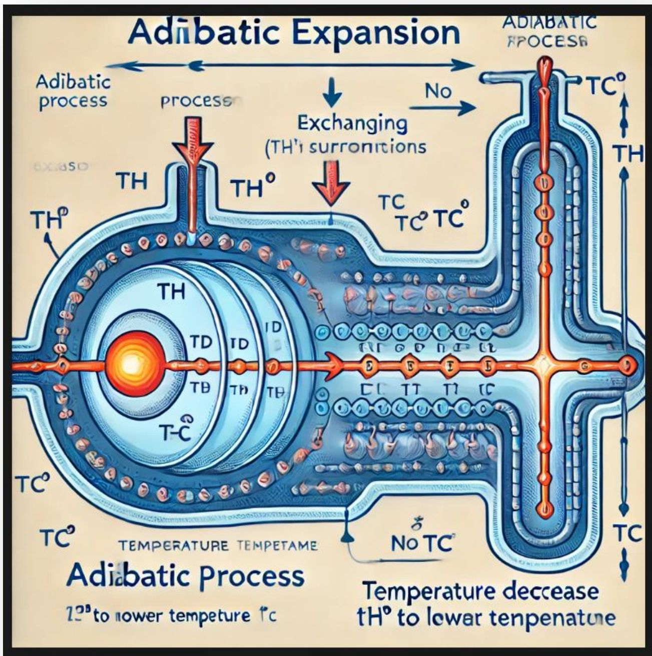


1. **Isothermal Expansion (Process 1-2):** The working substance (usually a gas) absorbs heat (Q_H) from the hot reservoir at a constant temperature T_H. During this process, the gas expands, doing work on the surroundings.



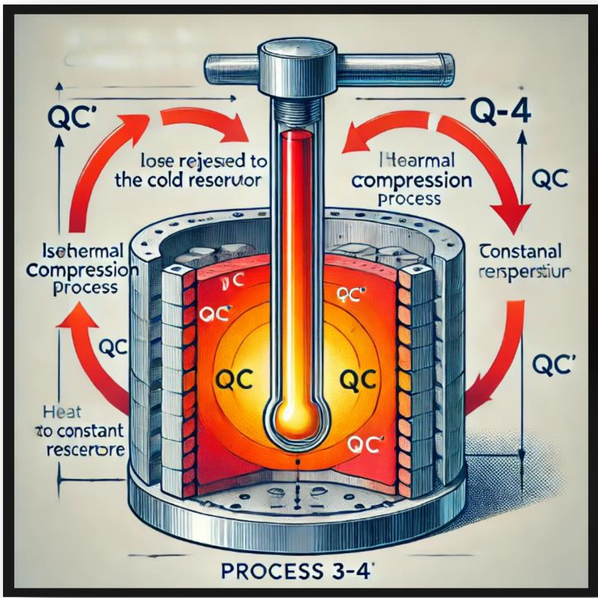
Here is the diagram illustrating the isothermal expansion process, where the gas absorbs heat from the hot reservoir and expands while doing work on the surroundings.

2. **Adiabatic Expansion (Process 2-3):** The gas continues to expand without heat exchange with the environment. Its temperature decreases from T_H to T_C.



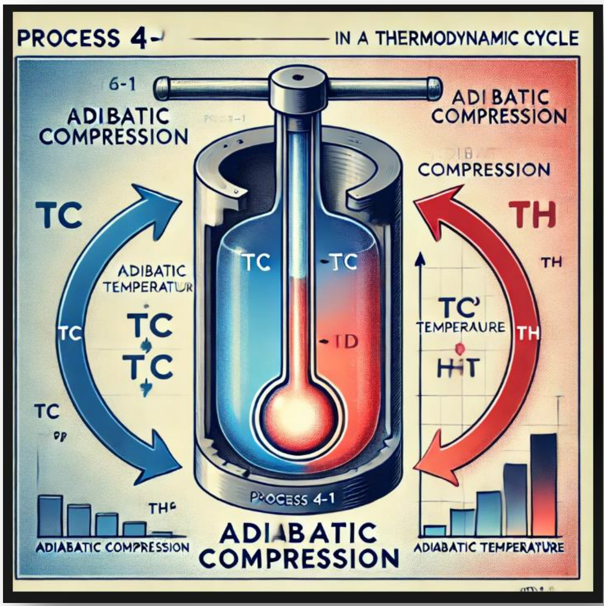
The diagram illustrating the adiabatic expansion process in thermodynamics has been generated.

3. **Isothermal Compression (Process 3-4):** The gas is compressed at a constant temperature T_C, rejecting heat (Q_C) to the cold reservoir. Work is done on the gas.

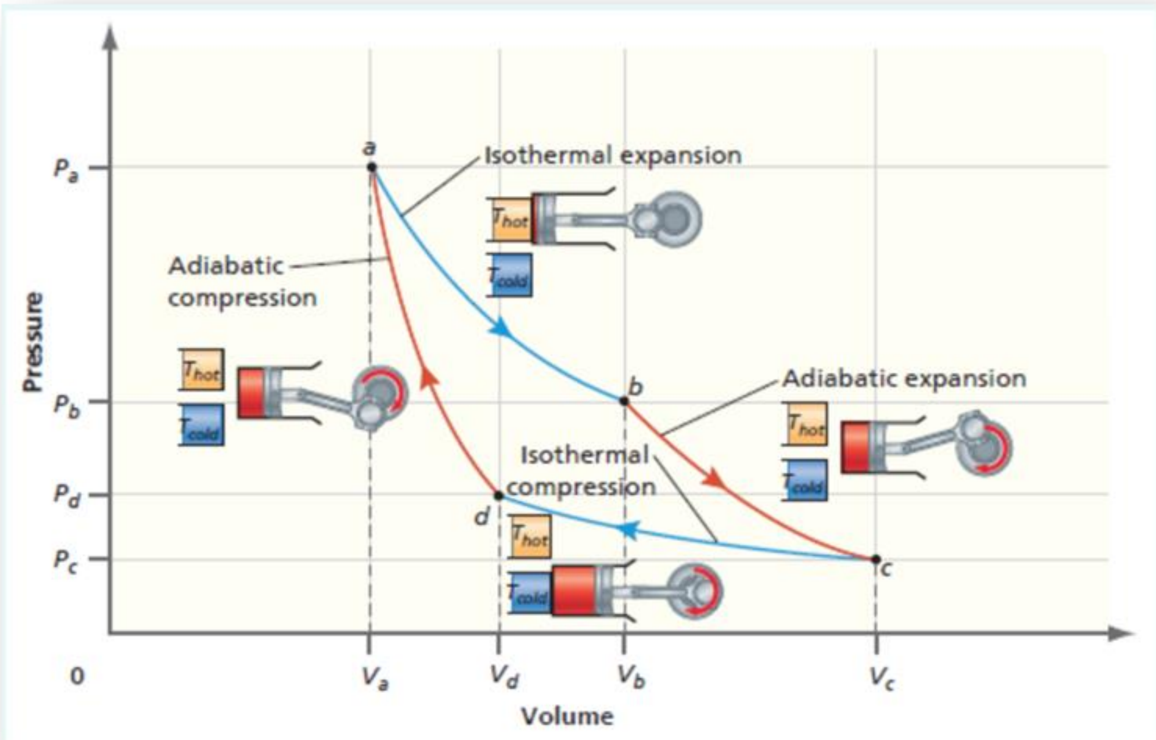


Here is the image illustrating the isothermal compression process (Process 3-4) where the gas is compressed at a constant temperature T_C, rejecting heat Q_C to the cold reservoir.

4. **Adiabatic Compression (Process 4-1):** The gas is further compressed adiabatically, raising its temperature from T_C back to T_H.



Here is the visual representation of the adiabatic compression process. It shows the compression of gas, along with the temperature increase from T_C to T_H.



C. Efficiency of the Carnot Cycle

The efficiency (η) of the Carnot cycle can be calculated using the following formula:

$$\eta = 1 - \frac{T_C}{T_H}$$

Where:

- T_H = Absolute temperature of the hot reservoir (Kelvin)
- T_C = Absolute temperature of the cold reservoir (Kelvin)

D. Example Problem:

Calculate the efficiency of a Carnot engine operating between 500 K (hot reservoir) and 300 K (cold reservoir).

Solution:

$$\eta = 1 - \frac{T_C}{T_H} = 1 - \frac{300}{500} = 0.4 \text{ or } 40\%$$

Reversed Carnot Cycle

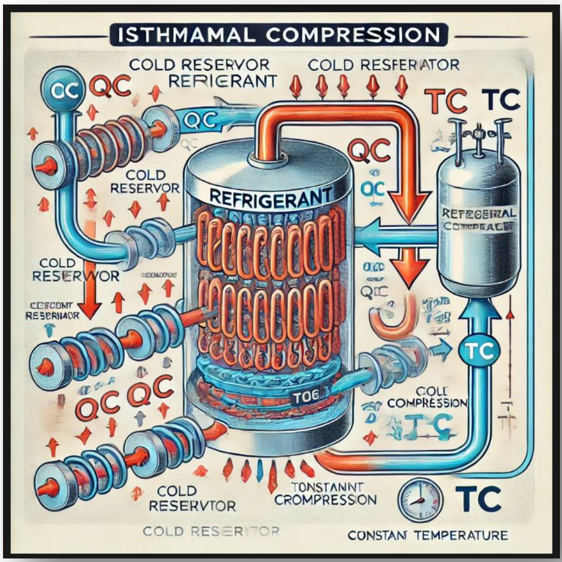
A. Definition

- **Reversed Carnot Cycle:** A thermodynamic cycle that operates in reverse, converting work into heat transfer from a cold reservoir to a hot reservoir. This cycle is essential in refrigeration and heat pump applications.

B. Components of the Reversed Carnot Cycle

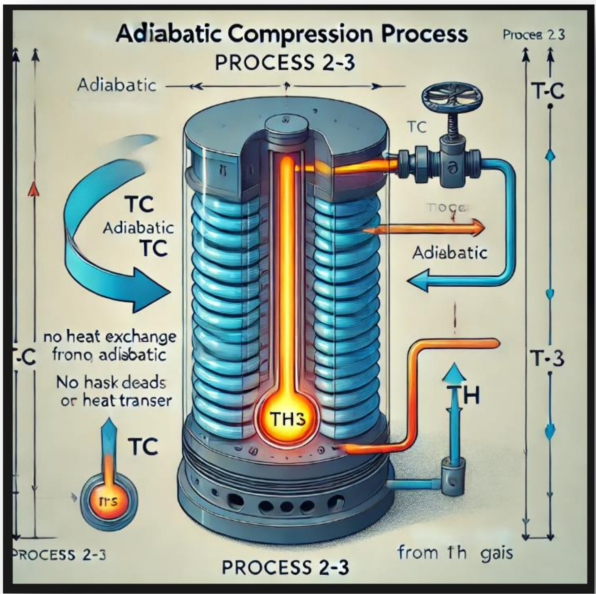
The reversed Carnot cycle also consists of four processes, but they operate in the opposite direction:

1. **Isothermal Compression (Process 1-2):** The refrigerant absorbs heat (Q_C) from the cold reservoir at a constant temperature T_C while being compressed.



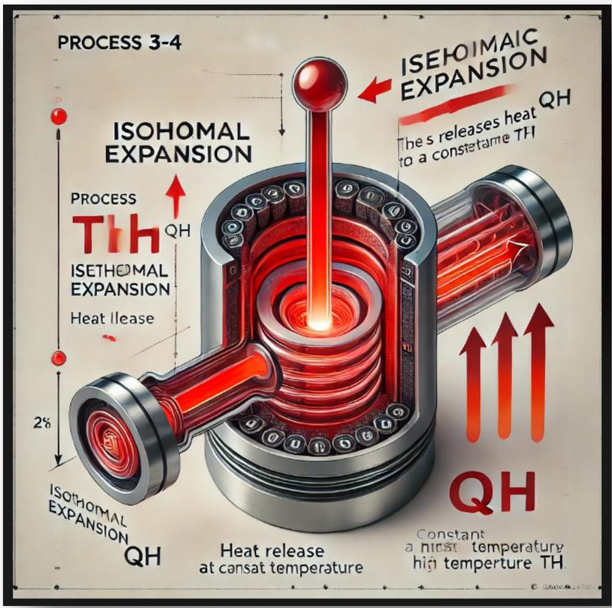
Here is the illustration of the isothermal compression process in a refrigeration cycle, showing the refrigerant absorbing heat from the cold reservoir at a constant temperature.

2. **Adiabatic Compression (Process 2-3):** The refrigerant continues to be compressed adiabatically, increasing its temperature from T_C to T_H.



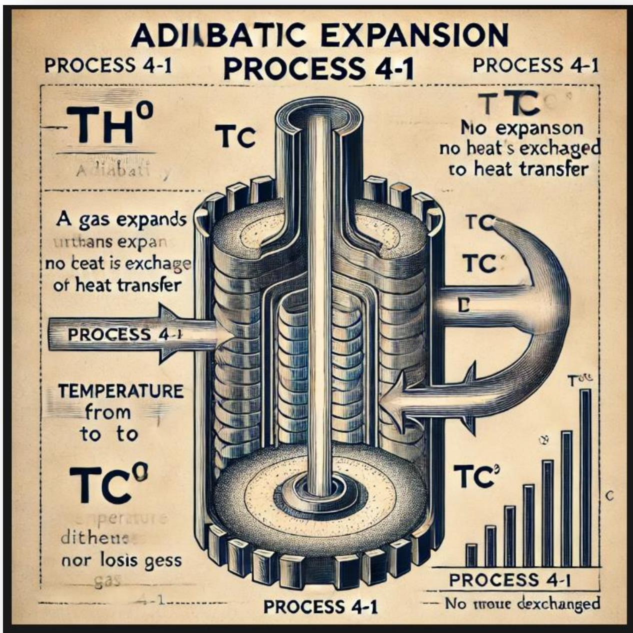
Here is the image illustrating the adiabatic compression process (Process 2-3), where the gas is compressed without heat exchange, resulting in a temperature rise from T_C to T_H.

3. **Isothermal Expansion (Process 3-4):** The refrigerant releases heat (Q_H) to the hot reservoir at a constant temperature T_H.



Here is the visual representation of the isothermal expansion process, showing the refrigerant releasing heat (QH) to the hot reservoir at a constant temperature (TH).

4. **Adiabatic Expansion (Process 4-1):** The refrigerant expands adiabatically, decreasing its temperature back to T_C.



Here is the visual representation of the isothermal expansion process, showing the refrigerant releasing heat (Q_H) to the hot reservoir at a constant temperature (T_H).

C. Coefficient of Performance (COP)

The efficiency of the reversed Carnot cycle is measured using the coefficient of performance (COP), given by:

$$COP = \frac{Q_C}{W} = \frac{T_C}{T_H - T_C}$$

Where:

- Q_C = Heat absorbed from the cold reservoir
- W = Work input

D. Example Problem:

Calculate the COP of a Carnot refrigerator operating between 280 K (cold reservoir) and 320 K (hot reservoir).

Solution:

$$COP = \frac{T_C}{T_H - T_C} = \frac{280}{320 - 280} = \frac{280}{40} = 7$$

Applications of the Carnot Cycle

A. Heat Engines

- The Carnot cycle serves as a benchmark for real heat engines, allowing engineers to evaluate performance and design more efficient systems.

B. Refrigeration Systems

- The reversed Carnot cycle is the ideal model for refrigeration cycles, providing insights into improving the efficiency of real refrigerators and air conditioners.

C. Heat Pumps

- Similar to refrigeration, heat pumps utilize the reversed Carnot cycle to transfer heat from a cold space to a warmer space, enhancing energy efficiency in heating applications.

Post-Lecture Questions:

1. Why is the Carnot cycle considered an ideal model, and what are its limitations in real-world applications?
2. How can engineers improve the efficiency of refrigeration systems based on the principles of the reversed Carnot cycle?
3. Can you provide examples of real-life applications where the Carnot cycle is used as a standard for performance measurement?

The Eighteenth and Nineteenth Lecture

(Study of Steam and Steam Properties – Using Steam Tables)

Pre-Lecture Questions:

1. What is steam, and why is it important in thermodynamic systems?
2. How does steam behave when it changes phases?
3. What are the main applications of steam in mechanical systems?

Definitions and Key Concepts:

1. **Steam:**
    - Steam is the vapor form of water that is produced when water is heated above its boiling point. In thermodynamic systems, steam is often used as a working fluid, especially in power plants and heating systems.
2. **Saturation Temperature and Pressure:**
    - The saturation temperature is the temperature at which water boils for a given pressure. Conversely, saturation pressure is the pressure at which water boils for a given temperature. The relationship between temperature and pressure is critical in steam systems.
3. **Phases of Steam:**
    - **Wet Steam:** Contains both water and steam (two-phase mixture).
    - **Dry Saturated Steam:** Steam that contains no water droplets and exists at the saturation temperature.
    - **Superheated Steam:** Steam that is heated beyond its saturation temperature.
4. **Steam Properties:**
    - **Specific Volume (v):** The volume occupied by a unit mass of steam.
    - **Enthalpy (h):** The total energy content of the steam per unit mass. It includes both internal energy and flow work.

- **Entropy (s):** A measure of disorder in the steam system, often used to determine the direction of heat transfer processes.

Steam Tables:

Steam tables are used to determine the thermodynamic properties of steam (like temperature, pressure, enthalpy, and specific volume) at various stages (liquid, vapor, or mixture). They are essential for analyzing thermodynamic cycles, especially in systems using steam like Rankine cycles.

- **Saturated Steam Table:** Lists properties of steam at its saturation point for various pressures and temperatures.

Saturated Water and Steam

p [bar]	T_s [°C]	v_g [m³/kg]	u_f [kJ/kg]	u_g [kJ/kg]	h_f [kJ/kg]	h_{fg} [kJ/kg]	h_g [kJ/kg]	s_f [kJ/kg K]	s_{fg} [kJ/kg K]	s_g [kJ/kg K]
0.006112	0.01	206.1	0†	2375	0*	2501	2501	0†	9.155	9.155
0.010	7.0	129.2	29	2385	29	2485	2514	0.106	8.868	8.974
0.015	13.0	87.98	55	2393	55	2470	2525	0.196	8.631	8.827
0.020	17.5	67.01	73	2399	73	2460	2533	0.261	8.462	8.723
0.025	21.1	54.26	88	2403	88	2451	2539	0.312	8.330	8.642
0.030	24.1	45.67	101	2408	101	2444	2545	0.354	8.222	8.576
0.035	26.7	39.48	112	2412	112	2438	2550	0.391	8.130	8.521
0.040	29.0	34.80	121	2415	121	2433	2554	0.422	8.051	8.473
0.045	31.0	31.14	130	2418	130	2428	2558	0.451	7.980	8.431
0.050	32.9	28.20	138	2420	138	2423	2561	0.476	7.918	8.394
0.055	34.6	25.77	145	2422	145	2419	2564	0.500	7.860	8.360
0.060	36.2	23.74	152	2425	152	2415	2567	0.521	7.808	8.329
0.065	37.7	22.02	158	2427	158	2412	2570	0.541	7.760	8.301
0.070	39.0	20.53	163	2428	163	2409	2572	0.559	7.715	8.274
0.075	40.3	19.24	169	2430	169	2405	2574	0.576	7.674	8.250
0.080	41.5	18.10	174	2432	174	2402	2576	0.593	7.634	8.227
0.085	42.7	17.10	179	2434	179	2400	2579	0.608	7.598	8.206
0.090	43.8	16.20	183	2435	183	2397	2580	0.622	7.564	8.186
0.095	44.8	15.40	188	2436	188	2394	2582	0.636	7.531	8.167
0.100	45.8	14.67	192	2437	192	2392	2584	0.649	7.500	8.149
0.12	49.4	12.36	207	2442	207	2383	2590	0.696	7.389	8.085
0.14	52.6	10.69	220	2446	220	2376	2596	0.737	7.294	8.031
0.16	55.3	9.432	232	2450	232	2369	2601	0.772	7.213	7.985
0.18	57.8	8.444	242	2453	242	2363	2605	0.804	7.140	7.944
0.20	60.1	7.648	251	2456	251	2358	2609	0.832	7.075	7.907
0.22	62.2	6.994	260	2459	260	2353	2613	0.858	7.016	7.874
0.24	64.1	6.445	268	2461	268	2348	2616	0.882	6.962	7.844
0.26	65.9	5.979	276	2464	276	2343	2619	0.904	6.913	7.817
0.28	67.5	5.578	283	2466	283	2339	2622	0.925	6.866	7.791
0.30	69.1	5.228	289	2468	289	2336	2625	0.944	6.823	7.767
0.32	70.6	4.921	295	2470	295	2332	2627	0.962	6.783	7.745

- **Superheated Steam Table:** Provides data for steam that is heated above the saturation temperature.

Superheated Steam†

p/[bar] (T_s/[°C])			T [°C]	50	100	150	200	250	300	400	500
0			v								
	$u = h - RT$		u	2446	2517	2589	2662	2737	2812	2969	3132
	at $p = 0$		h	2595	2689	2784	2880	2978	3077	3280	3489
			s								
0.006112 (0.01)	v_g	206.1	v	243.9	281.7	319.5	357.3	395.0	432.8	508.3	583.8
	u_g	2375	u	2446	2517	2589	2662	2737	2812	2969	3132
	h_g	2501	h	2595	2689	2784	2880	2978	3077	3280	3489
	s_g	9.155	s	9.468	9.739	9.978	10.193	10.390	10.571	10.897	11.187
0.01 (7.0)	v_g	129.2	v	149.1	172.2	195.3	218.4	241.4	264.5	310.7	356.8
	u_g	2385	u	2446	2517	2589	2662	2737	2812	2969	3132
	h_g	2514	h	2595	2689	2784	2880	2978	3077	3280	3489
	s_g	8.974	s	9.241	9.512	9.751	9.966	10.163	10.344	10.670	10.960
0.05 (32.9)	v_g	28.20	v	29.78	34.42	39.04	43.66	48.28	52.90	62.13	71.36
	u_g	2420	u	2445	2516	2589	2662	2737	2812	2969	3132
	h_g	2561	h	2594	2688	2784	2880	2978	3077	3280	3489
	s_g	8.394	s	8.496	8.768	9.008	9.223	9.420	9.601	9.927	10.217
0.1 (45.8)	v_g	14.67	v	14.87	17.20	19.51	21.83	24.14	26.45	31.06	35.68
	u_g	2437	u	2443	2516	2588	2662	2736	2812	2969	3132
	h_g	2584	h	2592	2688	2783	2880	2977	3077	3280	3489
	s_g	8.149	s	8.173	8.447	8.688	8.903	9.100	9.281	9.607	9.897
0.5 (81.3)	v_g	3.239	v		3.420	3.890	4.356	4.821	5.284	6.209	7.134
	u_g	2483	u		2512	2585	2660	2735	2812	2969	3132
	h_g	2645	h		2683	2780	2878	2976	3076	3279	3489
	s_g	7.593	s		7.694	7.940	8.158	8.355	8.537	8.864	9.154
0.75 (91.8)	v_g	2.217	v		2.271	2.588	2.901	3.211	3.521	4.138	4.755
	u_g	2496	u		2510	2585	2659	2734	2811	2969	3132
	h_g	2662	h		2680	2779	2877	2975	3075	3279	3489
	s_g	7.456	s		7.500	7.750	7.969	8.167	8.349	8.676	8.967
1	v_g	1.694	v		1.696	1.937	2.173	2.406	2.639	3.103	3.565
	u_g	2506	u		2506	2583	2659	2734	2811	2968	3131

Examples of Using Steam Tables:

1. **Saturated Steam Example:**
    - If we have water at 100°C and standard atmospheric pressure, the steam tables show the corresponding saturation pressure is 101.3 kPa.
2. **Superheated Steam Example:**
    - For steam at a temperature of 200°C and a pressure of 1 MPa, we can use the superheated steam tables to find its enthalpy and entropy.

Applications of Steam:

1. **Power Generation:**
    - Steam is a key component in thermal power plants, where it drives turbines to generate electricity.
2. **Heating Systems:**
    - Steam is also used in heating applications, such as in boilers for residential or industrial use.
3. **Refrigeration and Cooling:**
    - Steam can be utilized in absorption refrigeration systems, making use of waste heat in a steam cycle.

Example Problems:

1. **Problem 1:** Calculate the specific volume and enthalpy of saturated steam at 150°C using the steam tables.

   Solution: From the steam tables, at 150°C:

   - Specific volume v_g = 0.3923 m³/kg
   - Enthalpy h_g = 2776.2 kJ/kg

2. **Problem 2:** If steam at 1 MPa is superheated to 300°C, find the enthalpy and specific volume from the superheated steam tables.

   Solution: From the superheated steam tables, at 1 MPa and 300°C:

   - Enthalpy h_g = 3068 kJ/kg
   - Specific volume v_g = 0.2572 m³/kg

Post-Lecture Questions:

1. What are the differences between wet steam, dry steam, and superheated steam?
2. How can steam tables be used to calculate the properties of steam in a Rankine cycle?
3. Why is steam superheating important in power plants?

The Twentieth Lecture

Calculations of the Properties for Liquid-Vapor Mixture (Wet Steam)

Pre-Lecture Questions:

1. What is the difference between dry steam and wet steam?
2. Why is it important to calculate the properties of liquid-vapor mixtures in thermodynamics?
3. How do we use steam tables to find properties of wet steam?

Definitions and Key Concepts:

1. **Wet Steam (Liquid-Vapor Mixture):**
   - Wet steam refers to steam that contains both liquid water and vapor in a mixture. It occurs when steam is not fully vaporized and still has droplets of liquid water suspended in it.
   - Wet steam is characterized by the dryness fraction (x), which indicates the proportion of vapor in the mixture. The dryness fraction ranges from 0 (pure liquid) to 1 (pure vapor).

2. **Dryness Fraction (x):**
   - The dryness fraction is a key property in determining the condition of wet steam. It is defined as:

   $$x = \frac{\text{mass of vapor}}{\text{total mass of mixture}}$$

   A value of $x = 0.8$ means that 80% of the mixture is vapor and 20% is liquid.

3. **Specific Properties of Wet Steam:**
   - The properties of wet steam (such as enthalpy, volume, and entropy) depend on the dryness fraction. These properties can be calculated using the following general formulas:

   $$h_{\text{wet}} = h_f + x(h_g - h_f)$$

   $$v_{\text{wet}} = v_f + x(v_g - v_f)$$

   $$s_{\text{wet}} = s_f + x(s_g - s_f)$$

   - Where h_f, v_f, s_f represent the saturated liquid properties, and h_g, v_g, s_g represent the saturated vapor properties.

4. **Steam Tables:**
   - Steam tables are used to find the values of enthalpy (h_f, h_g), volume (v_f, v_g), and entropy (s_f, s_g) at specific pressures or temperatures.

Detailed Calculations for Wet Steam Properties:

Example 1: Enthalpy of Wet Steam

- **Given:**
  - Pressure: 1 MPa
  - Dryness fraction (x): 0.85
- **From the steam table:**
  - At 1 MPa: $h_f = 762.8\,\mathrm{kJ/kg}, h_g = 2777.1\,\mathrm{kJ/kg}$
- **Calculation:**

$$h_{\mathrm{wet}} = h_f + x(h_g - h_f)$$

$$h_{\mathrm{wet}} = 762.8 + 0.85 \times (2777.1 - 762.8)$$

$$h_{\mathrm{wet}} = 762.8 + 0.85 \times 2014.3$$

$$h_{\mathrm{wet}} = 762.8 + 1712.2 = 2475\,\mathrm{kJ/kg}$$

Example 2: Specific Volume of Wet Steam

- **Given:**
  - Pressure: 500 kPa
  - Dryness fraction (x): 0.7
- **From the steam table:**
  - At 500 kPa: $v_f = 0.001093\,\mathrm{m^3/kg}, v_g = 0.3749\,\mathrm{m^3/kg}$
- **Calculation:**

$$v_{\mathrm{wet}} = v_f + x(v_g - v_f)$$

$$v_{\mathrm{wet}} = 0.001093 + 0.7 \times (0.3749 - 0.001093)$$

$$v_{\mathrm{wet}} = 0.001093 + 0.7 \times 0.373807$$

$$v_{\mathrm{wet}} = 0.001093 + 0.261665 = 0.262758\,\mathrm{m^3/kg}$$

Practical Applications of Wet Steam:

1. **Steam Turbines:**
   - Wet steam is common in steam turbines. Managing the dryness fraction is critical because a high percentage of liquid water can damage turbine blades.
2. **Heat Exchangers:**
   - In heat exchangers, wet steam is often used to transfer heat efficiently. Controlling the dryness fraction helps optimize heat transfer while preventing excessive condensation.
3. **Steam Heating Systems:**

- Wet steam is used in heating systems where heat is transferred from the steam to another medium, such as water or air. Ensuring proper steam quality improves the efficiency of the system.

Example Problems:

1. **Problem 1:**
   - Find the enthalpy of wet steam with a dryness fraction of 0.6 at a pressure of 200 kPa.

   Solution:

   - From the steam tables:
     - $h_f = 504.7\,\text{kJ/kg}, h_g = 2201.3\,\text{kJ/kg}$

   $$h_{\text{wet}} = 504.7 + 0.6 \times (2201.3 - 504.7) = 504.7 + 1017.96 = 1522.66\,\text{kJ/kg}$$

2. **Problem 2:**
   - Calculate the specific volume of wet steam at 600 kPa with a dryness fraction of 0.75.

   Solution:

   - From the steam tables:
     - $v_f = 0.001101\,\text{m}^3/\text{kg}, v_g = 0.3157\,\text{m}^3/\text{kg}$

   $$v_{\text{wet}} = 0.001101 + 0.75 \times (0.3157 - 0.001101) = 0.001101 + 0.235572 = 0.236673\,\text{m}^3/\text{kg}$$

Post-Lecture Questions:

1. How does the dryness fraction affect the properties of wet steam?
2. Why is it important to calculate the enthalpy and volume of wet steam in thermodynamic applications?
3. What are some practical systems where controlling the dryness fraction of steam is critical?

الفصل الثاني: رقم المحاضرة: 25+24+23+22+21	
عنوان المحاضرات:	العمليات على البخارية عند الضغط وحجم ثابت - العملية المتساوية الحركة والعملية الأديباتية وتطبيقاتها، دورة رانكين - العمليات، والأمثلة، دورة ضغط البخار - العمليات والأمثلة وتطبيقاتها
اسـم المدرسين:	م.م. مرال محمود حسين و م. محمود حسين خليل
الفئة المستهدفة :	المرحلة الاولى/ المعهد التقني
الهدف العام من المحاضرة :	تزويد الطلاب بالمعرفة والفهم والتطبيق والتحليل والتقويم في علم ديناميك الحرارة والعمليات على البخارية عند الضغط وحجم ثابت - العملية المتساوية الحركة والعملية الأديباتية وتطبيقاتها، دورة رانكين - العمليات، والأمثلة، دورة ضغط البخار - العمليات والأمثلة وتطبيقاتها
الأهداف السلوكية او مخرجات التعلم:	1 - يتم تقييم فهم الطلاب للمفاهيم الثرموديناميكية من خلال الاختبارات الكتابية التقليدية. 2 - يتم تقييم القدرة على التطبيق في حل المشكلات. 3 - يتم تقييم القدرة على تطبيق المعرفة الرياضية في سياقات العالم الحقيقي. 4- يتم تقييم القدرة على التواصل الفعال للأفكار والمفاهيم الرياضية والمعرفية.
استراتيجيات التيسير المستخدمة	1. المحاضرات 2. التعلم النشط 3. التعلم القائم على المشروع 4. التعلم الذاتي 5. التعلم الرقمي 6. التقييم المستمر
المهارات المكتسبة	سيكون لدى الطالب قابلية التطوير والقدرة على التفكير المنطقي والتحليلي والنقدي في حل المشكلات التخصصية في الجانب الحراري والرياضي والهندسي.
طرق القياس المعتمدة	الامتحانات اليومية والشهرية و تكليف الطلاب بمشاريع تتطلب تطبيق المعرفة

The Twenty-First and Twenty-Second Lecture

(Steam Processes at Constant Pressure, Volume - Isentropic Process, Adiabatic Process & Applications)

Pre-Lecture Questions:

1. What is the difference between constant pressure and constant volume processes?
2. How is an isentropic process different from an adiabatic process?
3. Where are these processes applied in refrigeration and air conditioning systems?

Key Definitions and Concepts:

1. Steam Process at Constant Pressure (Isobaric Process):

- In an isobaric process, the pressure remains constant throughout, but the volume and temperature can change. This process is common in boilers, condensers, and other steam applications.
- **Formula for Work Done (W) in Isobaric Process:**

$$W = P\Delta V$$

  Where P is the constant pressure and ΔV is the change in volume.

- **Application:**
  - A typical example is the boiler in steam power plants, where water is heated at constant pressure to convert it into steam.

2. Steam Process at Constant Volume (Isochoric Process):

- In an isochoric process, the volume remains constant, but the pressure and temperature can change. No work is done since there is no change in volume.

  Formula:

$$W = 0$$

- **Application:**
  - In certain phases of refrigeration cycles, such as in closed containers, the volume remains constant as heat is added or removed.

3. Isentropic Process:

- An isentropic process is a **reversible adiabatic process** where there is no change in entropy ($\Delta S = 0$). Heat transfer does not occur, but work can be done.
- **Formula for Isentropic Process (Steam):**

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{(\gamma-1)/\gamma}$$

Where T_1,T_2 are temperatures, P_1,P_2 are pressures, and γ is the specific heat ratio.

- **Application:**
  - Isentropic processes occur in the compression and expansion stages of turbines and compressors in refrigeration cycles, where the process is nearly reversible and adiabatic.

4. Adiabatic Process:

- In an adiabatic process, no heat is transferred into or out of the system ($Q=0$). It can be reversible or irreversible. In this case, all the energy is used to perform work or change internal energy.
- **Formula for Adiabatic Process:**

$$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$$

Where PPP is pressure, V is volume, and γ is the adiabatic index (ratio of specific heats).

- **Application:**
  - Adiabatic processes are common in compressors, where gases are compressed without exchanging heat with the surroundings.

Detailed Calculations for Isentropic and Adiabatic Processes:

Example 1: Isentropic Expansion in a Steam Turbine

- **Given:**
  - Initial Pressure (P_1) = 5 MPa
  - Final Pressure (P_2) = 1 MPa
  - Initial Temperature (T_1) = 500°C
- **From steam tables:**
  - At 5 MPa and 500°C, specific enthalpy h_1=3375 kJ/kg
  - At 1 MPa (isentropic expansion), use T_2 from tables.
- **Result:**
  - The expansion of steam in turbines can be modeled as an isentropic process where no heat is transferred, and the steam does work.

Example 2: Adiabatic Compression in a Compressor

- **Given:**
  - Initial Volume (V_1) = 0.5 m³
  - Final Volume (V_2) = 0.2 m³
  - Pressure before compression (P_1) = 200 kPa
- **Using Adiabatic Equation:**

$$P_2 = P_1 \left(\frac{V_1}{V_2}\right)^{\gamma}$$

Where $\gamma = 1.4$ for air.

- **Calculation:**

$$P_2 = 200 \times \left(\frac{0.5}{0.2}\right)^{1.4} = 200 \times 2.5^{1.4} = 672.3\,\text{kPa}$$

Applications in Refrigeration and Air Conditioning:

1. **Compressors (Adiabatic Process):**
   - Compressors in refrigeration systems often work under adiabatic conditions, where the gas is compressed without losing heat to the surroundings. This process raises the temperature and pressure of the refrigerant, which then flows through the condenser.
2. **Turbines (Isentropic Process):**
   - In steam turbines, steam expands isentropically, converting thermal energy into mechanical work. This process is critical in power plants and cooling systems.
3. **Heat Exchangers (Constant Pressure Process):**
   - In heat exchangers, especially in evaporators and condensers, the process is often conducted at constant pressure, facilitating efficient heat transfer.

Example Problems:

Problem 1:

- A steam turbine operates under isentropic conditions. If the inlet steam is at 6 MPa and 600°C, and the exit pressure is 0.1 MPa, find the final temperature after expansion using steam tables.

Solution:

- From steam tables, find h1h_1h1 at 6 MPa and 600°C, and then use the isentropic relationship to find the exit properties.

Problem 2:

- A compressor compresses air adiabatically. The initial pressure and volume are 100 kPa and 1 m^3, respectively, and the final volume is 0.2 m^3. Find the final pressure.

Solution:

- Using the adiabatic equation, calculate the final pressure using

$$P_2 = P_1 \left(\frac{V_1}{V_2}\right)^{\gamma},$$

where γ=1.4.

Post-Lecture Questions:

1. How do you differentiate between an isentropic and an adiabatic process in terms of heat exchange?
2. What role does constant pressure play in the functioning of boilers and condensers?
3. Where are isentropic and adiabatic processes commonly used in refrigeration cycles?

The Twenty-Third and Twenty-Fourth Lecture

(The Rankine Cycle - Processes, Examples)

Pre-Lecture Questions:

1. What is the Rankine cycle, and how is it different from other thermodynamic cycles?
2. What are the main components of a Rankine cycle?
3. How is the Rankine cycle applied in refrigeration and air conditioning systems?

Processes of the Rankine Cycle:

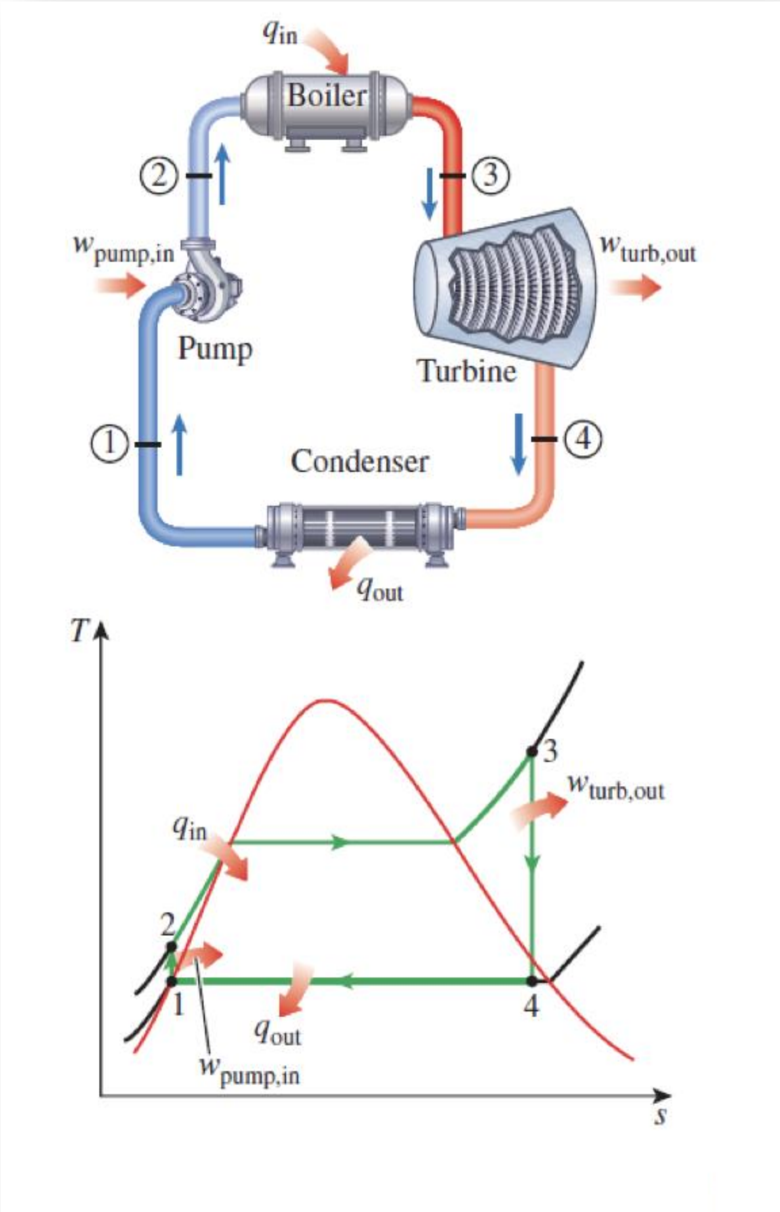
The Rankine cycle consists of **four main processes** that occur between the different components of the system:

1. **Isentropic Compression (Pump):**
    - **Process:** Water (in liquid state) is pumped from low pressure (in the condenser) to high pressure (in the boiler).
    - **Formula for work in the pump:**

$$W_{pump} = v \times \Delta P$$

where v is the specific volume, and ΔP is the pressure difference.

- **Application:** The pump raises the pressure of the liquid to the pressure of the boiler.



The simple ideal Rankine cycle.

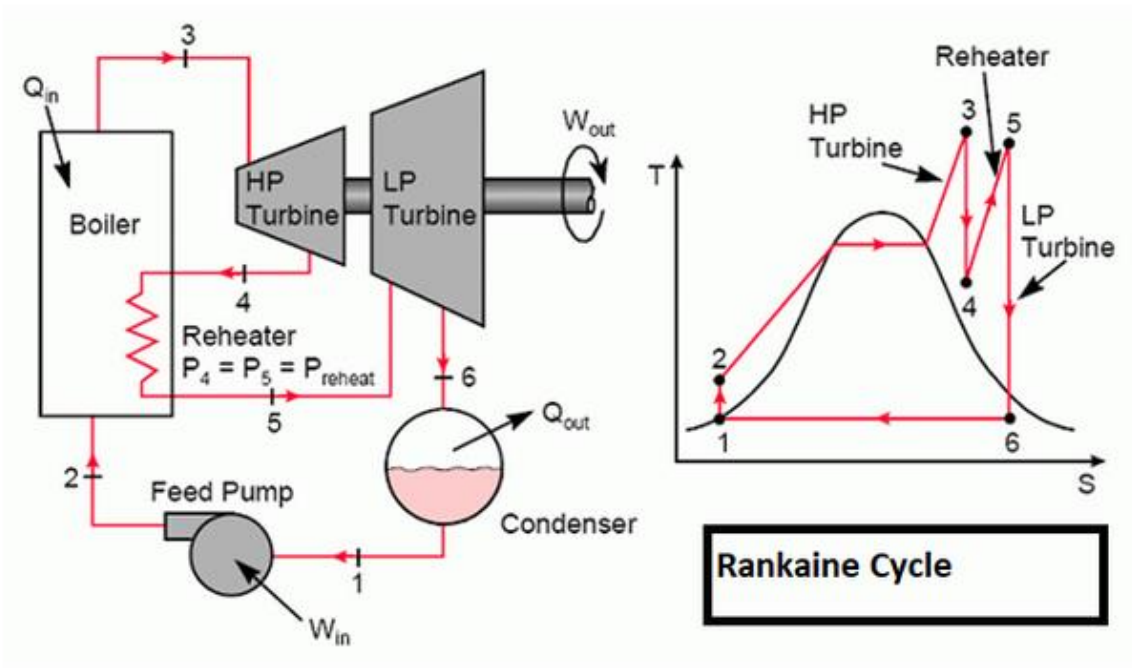
2. **Isobaric Heat Addition (Boiler):**
   - **Process:** The pressurized liquid enters the boiler, where it is heated at a constant pressure. As it absorbs heat, the water turns into steam.

- **Formula for heat added:**

$$Q_{in}=m\times(h_g-h_f)$$

where m is the mass flow rate, hg is the enthalpy of saturated steam, and hf is the enthalpy of saturated liquid.

- **Application:** The boiler adds heat to the system, converting the liquid into superheated steam.



Supercritical Boiler circuit Diagram

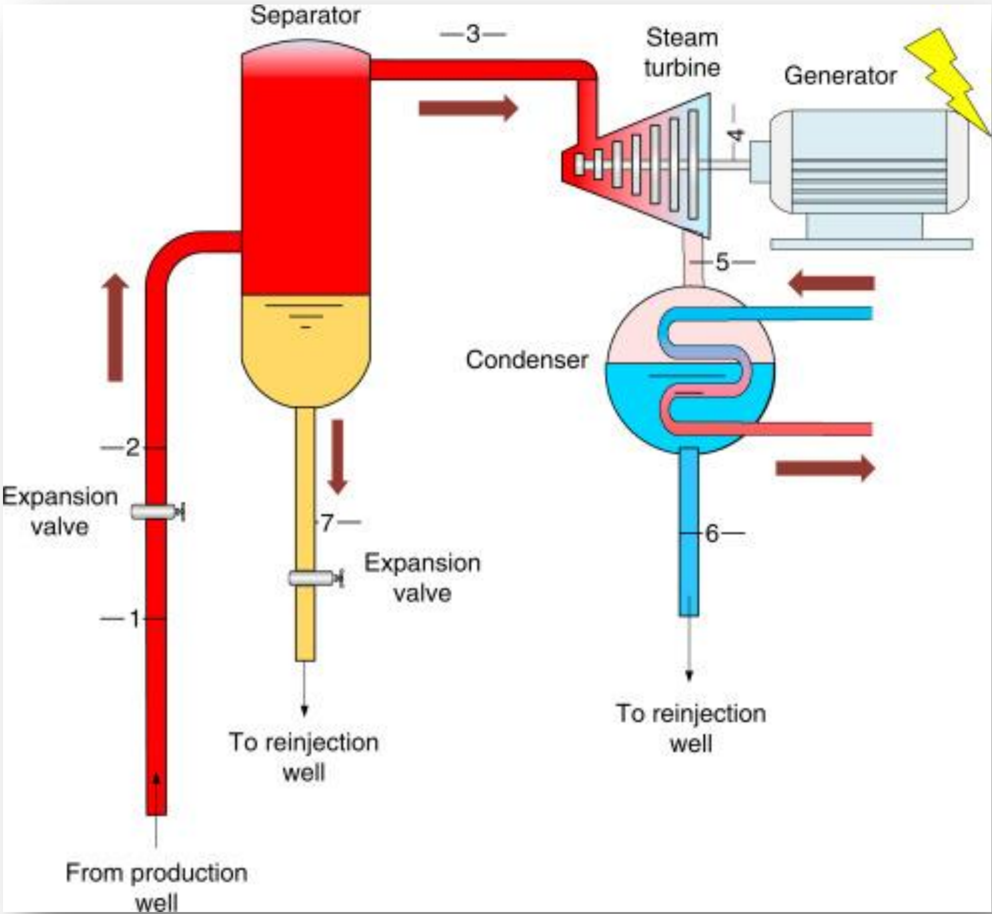
3. **Isentropic Expansion (Turbine):**
   - **Process:** The superheated steam expands through a turbine, converting the steam's thermal energy into mechanical work. This expansion happens at constant entropy (isentropic).

     Formula for turbine work:

$$W_{turbine}=m\times(h_{in}-h_{out})$$

where h_{in} and h_{out} are the specific enthalpies of steam at the inlet and outlet of the turbine.

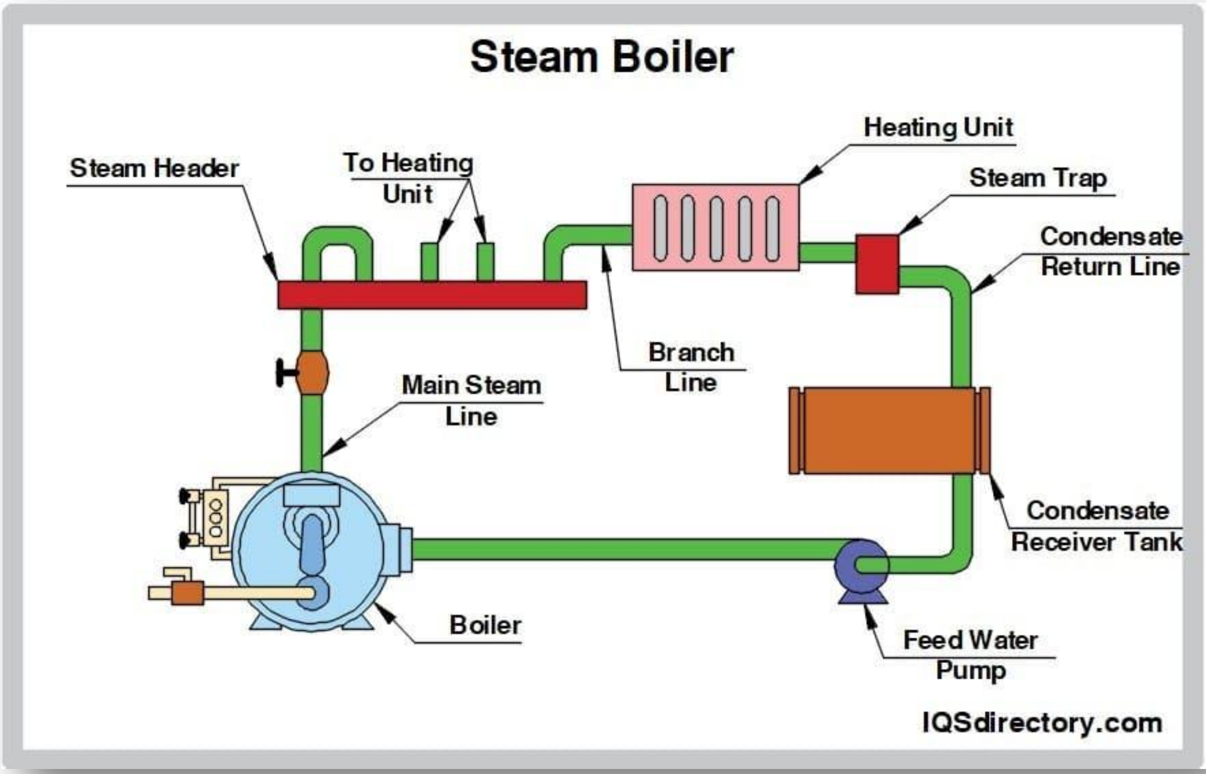
- **Application:** The steam drives the turbine to generate mechanical power.



4. **Isobaric Heat Rejection (Condenser):**
   - **Process:** The steam leaves the turbine at a lower pressure and temperature and enters the condenser, where it is cooled down at a constant pressure to become saturated water (or liquid).
   - **Formula for heat rejected:**

$$Q_{out}=m\times(h_g-h_f)$$

   - **Application:** The condenser removes the heat from the system, allowing the steam to condense into water and be pumped back to the boiler.



Rankine Cycle Efficiency:

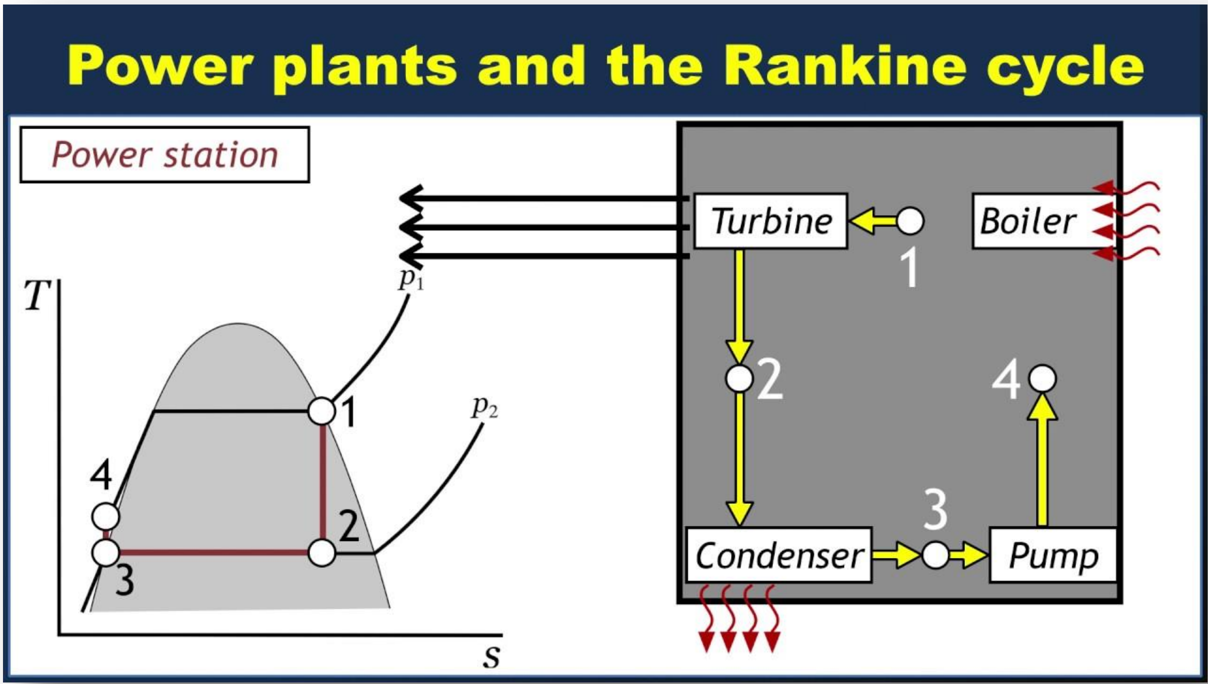
- The **efficiency of the Rankine cycle** can be calculated by comparing the net work output to the heat added:

$$\eta = \frac{W_{turbine} - W_{pump}}{Q_{in}}$$

- Increasing the efficiency of the Rankine cycle can be done by using **superheating**, **reheating**, or **regeneration** methods.

Applications of the Rankine Cycle:

1. **Power Plants:**
   - The most common application of the Rankine cycle is in **steam power plants**, where it converts thermal energy from the combustion of fossil fuels into electricity.



2. **Geothermal Plants:**
   - Geothermal plants also use the Rankine cycle by utilizing heat from the Earth's crust to produce steam, which drives turbines to generate electricity.
3. **Nuclear Power Plants:**
   - In nuclear plants, the heat produced by nuclear fission is used to generate steam, which then drives a turbine through the Rankine cycle.

Example Problem:

Problem 1:

A steam power plant operates on the Rankine cycle. Steam enters the turbine at 4 MPa and 400°C and is condensed in the condenser at 10 kPa. The pump operates with an isentropic efficiency of 100%. Calculate the work done by the turbine, work input to the pump, and the cycle efficiency.

- **Solution Steps:**

1. Use steam tables to find enthalpies at different stages.
2. Calculate turbine work: $W_{turbine} = m \times (h_{in} - h_{out})$.
3. Calculate pump work: $W_{pump} = v \times \Delta P$.
4. Calculate cycle efficiency using $\eta = \frac{W_{turbine} - W_{pump}}{Q_{in}}$.

Post-Lecture Questions:

1. How does the Rankine cycle convert heat into mechanical work?
2. What is the role of the condenser in the Rankine cycle?
3. How can you increase the efficiency of the Rankine cycle?
4. In what types of power plants is the Rankine cycle commonly used?

The Twenty-Fifth Lecture

(The Vapor Compression Cycle - Processes, Examples, and Applications)

Pre-Lecture Questions:

1. What is the basic principle of the vapor compression cycle used in refrigeration and air conditioning?
2. Can you identify the main components involved in the vapor compression cycle?
3. How does each process in the cycle contribute to the overall functioning of refrigeration systems?

Introduction to the Vapor Compression Cycle:

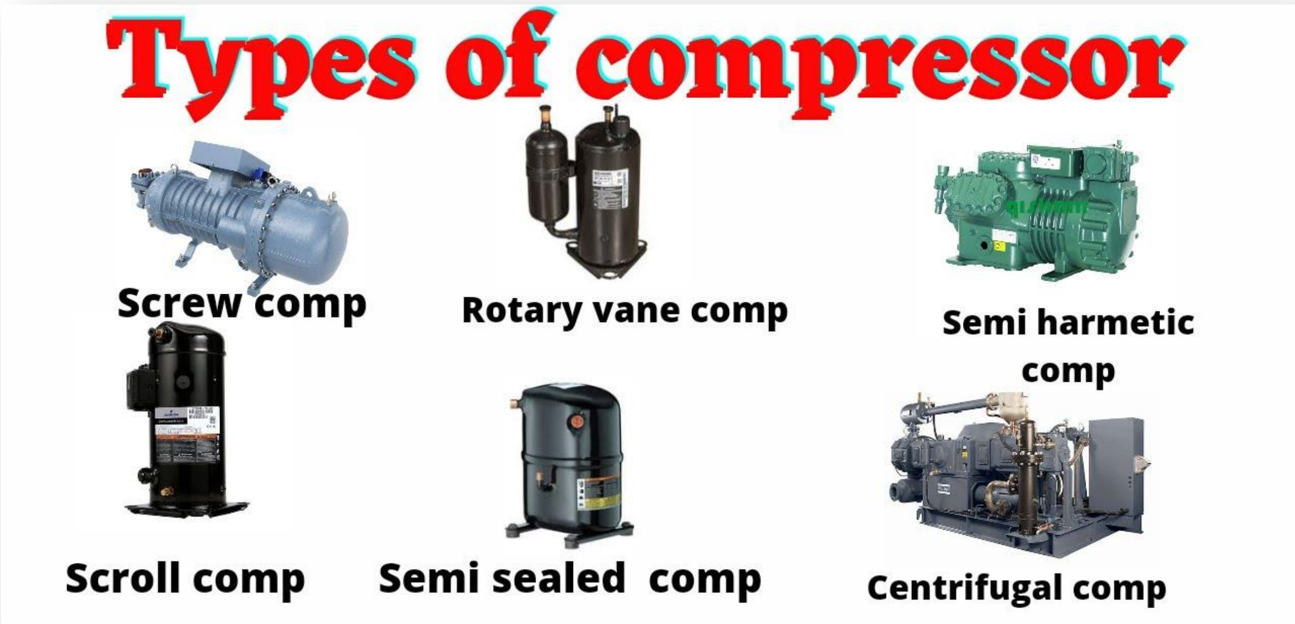
The **vapor compression cycle (VCC)** is a widely used thermodynamic cycle in refrigeration and air conditioning systems. It operates by removing heat from a designated area (low-temperature reservoir) and transferring it to another area (high-temperature reservoir) using a refrigerant. The cycle consists of four main processes: compression, condensation, expansion, and evaporation.

Processes of the Vapor Compression Cycle:

1. **Compression:**
    - **Description:** The low-pressure vapor refrigerant enters the compressor, where it is compressed to a high-pressure vapor. This process increases both the temperature and pressure of the refrigerant.
    - **Formula for Work Done:**

$$W_{compressor} = h_2 - h_1$$

Where h_1 and h_2 are the enthalpies at the inlet and outlet of the compressor, respectively.



2. **Condensation :**
    - **Description:** The high-pressure vapor refrigerant leaves the compressor and enters the condenser. In the condenser, the refrigerant releases heat to the

surrounding environment and changes from vapor to liquid at a constant pressure.

- **Formula for Heat Rejected:**

$$Q_{out}=h_2-h_3$$

Where h_3 is the enthalpy of the saturated liquid.

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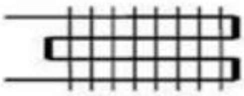
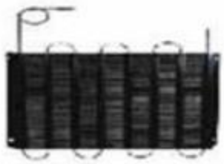
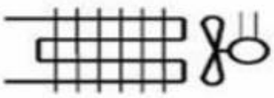
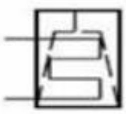
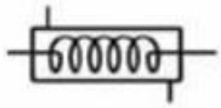
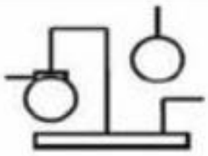
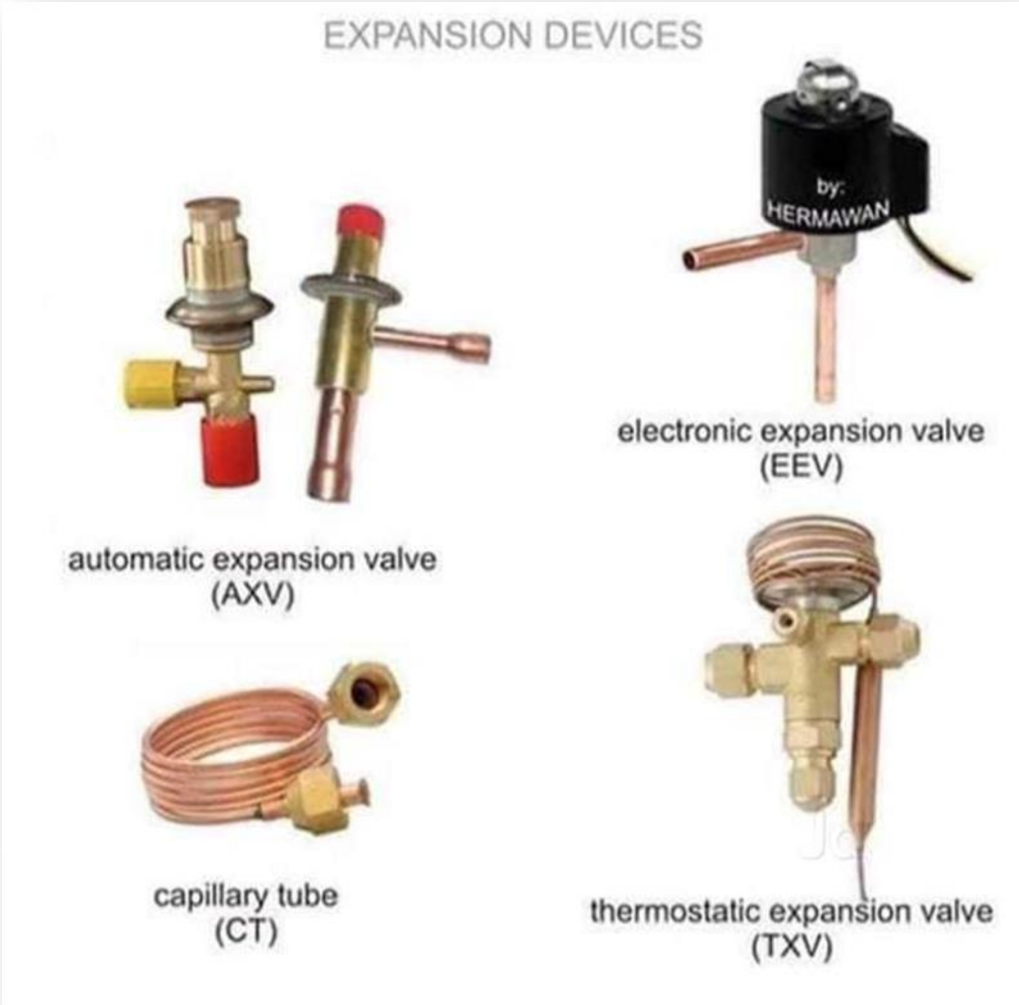
		مكثف مزعنف مبرد بالهواء ، حمل حر Finned air cooled condenser, static
		مكثف مزعنف مبرد بالهواء ، حمل قسري Finned air cooled condenser, forced air
		مكثف تبخيري Evaporative Condenser
		مكثف مبرد بالماء ذو غلاف و آنابيب Water cooled condenser, Shell and tube

الرمز	نموذج	العنصر
		مكثف مبرد بالماء ذو غلاف وملف Water cooled condenser, Shell and coil
		وحدة تكثيف مبردة بالهواء Air cooled condensing unit
		وحدة تكثيف مبردة بالماء Water cooled condensing unit
		ملف انبوبي Coil
		برج تبريد Cooling tower

3. **Expansion:**
   - **Description:** The high-pressure liquid refrigerant passes through an expansion valve, where it undergoes a sudden decrease in pressure, resulting in a drop in temperature as it expands.
   - **Heat Absorbed:**

$$Q_{in}=h_3-h_4$$

Where h_4 is the enthalpy of the vapor entering the evaporator.



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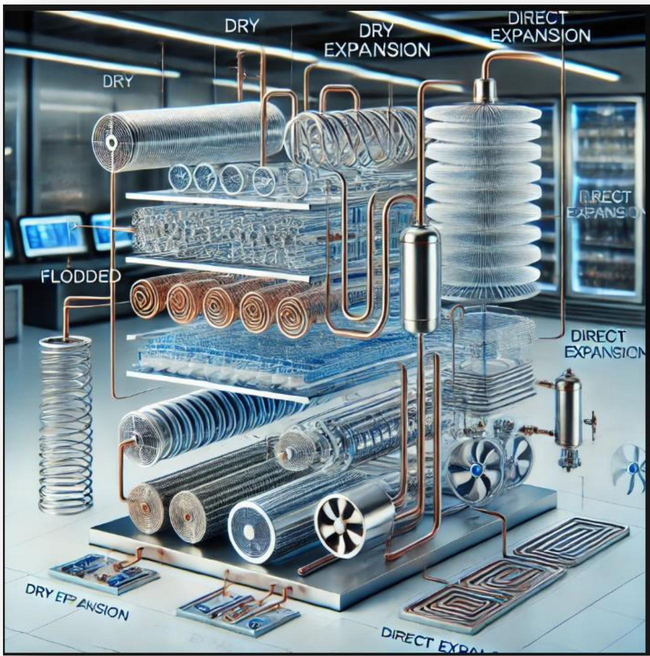
4. **Evaporation:**
   - **Description:** The low-pressure liquid refrigerant enters the evaporator, where it absorbs heat from the environment, causing it to evaporate into vapor at a constant temperature.
   - **Heat Absorption:**

$$Q_{in}=h_4-h_1$$



Vapor Compression Cycle Efficiency:

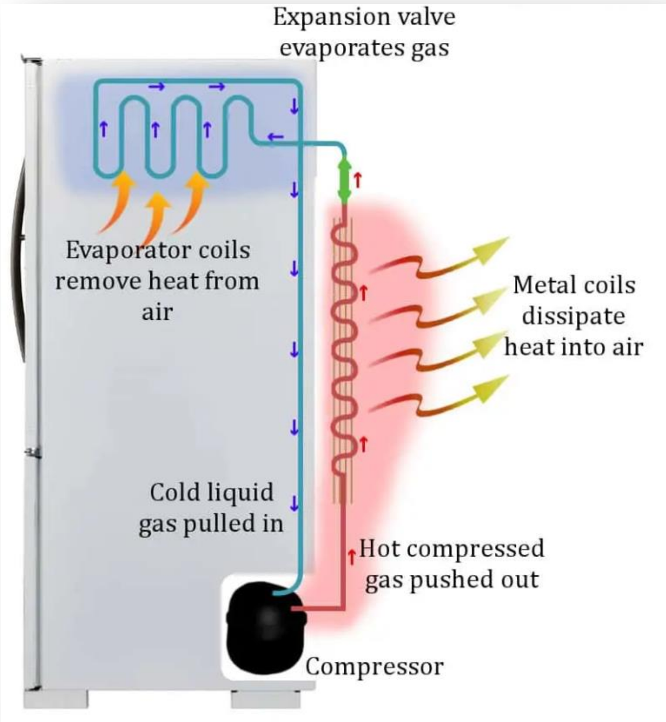
- The effectiveness of the vapor compression cycle is often assessed using the **Coefficient of Performance (COP)**, which indicates how efficiently the cycle performs cooling relative to the work input.
- **Formula for COP:**

$$COP = \frac{Q_{in}}{W_{compressor}}$$

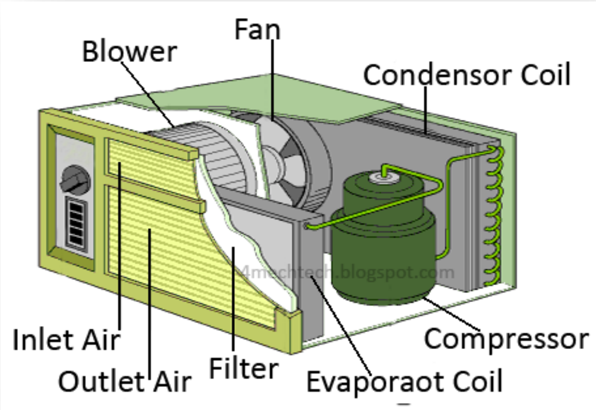
Where Q_{in} is the heat absorbed by the evaporator and $W_{compressor}$ is the work done by the compressor.

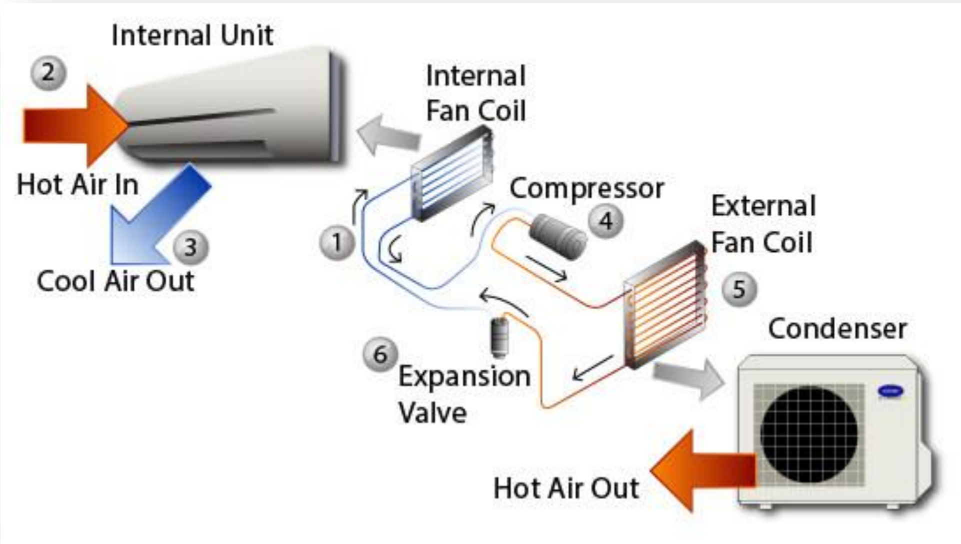
Applications of the Vapor Compression Cycle:

1. **Refrigeration Systems:**
    - The vapor compression cycle is fundamental in refrigeration systems, such as refrigerators and freezers, where it effectively removes heat from the interior to keep food and other perishables cool.
    - **Diagram of a Refrigerator Setup:**

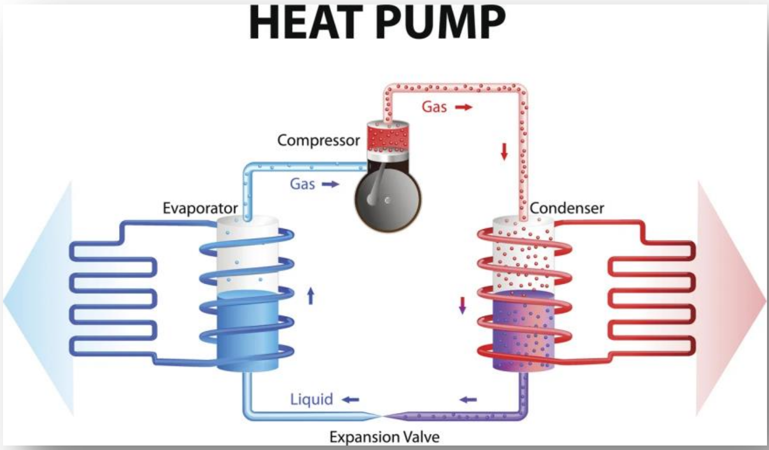


2. **Air Conditioning Systems:**
    - Air conditioners utilize the vapor compression cycle to cool indoor spaces, removing heat and providing comfort for occupants.
    - **Diagram of an Air Conditioning System:**





3. **Heat Pumps:**
   - Heat pumps operate on the vapor compression cycle, serving both heating and cooling purposes by reversing the flow of the refrigerant.
   - **Diagram of a Heat Pump System:**



Example Problems:

Problem 1:

A vapor compression refrigeration system operates with refrigerant R-134a. The refrigerant enters the compressor at 5°C and 1 bar and exits at 40°C and 8 bar. Calculate the work done by the compressor and the heat absorbed by the evaporator.

- **Steps to Solve:**
  1. Use refrigerant tables to find enthalpy values at different states.
  2. Calculate the work done by the compressor using the enthalpy values.
  3. Calculate the heat absorbed by the evaporator.

Problem 2:

An air conditioning system operates at a COP of 3. If the system provides 10 kW of cooling, how much work does the compressor do?

- **Formula to Solve:**

$$W_{compressor} = \frac{Q_{in}}{COP}$$

Post-Lecture Questions:

1. How does the vapor compression cycle work to provide cooling?
2. What is the significance of each component in the vapor compression cycle?
3. How can the performance of a vapor compression cycle be optimized?
4. What types of refrigerants are commonly used in vapor compression systems?

الفصل الاول: رقم المحاضرة: 30+29+28+27+26	
عنوان المحاضرات:	الوقود - التعاريف والخصائص والتطبيقات في الغلايات وأنظمة التبريد، الغلايات - أنواعها وخصائصها،
اسـم المدرسين:	م.م. مرال محمود حسين و م. محمود حسين خليل
الفئة المستهدفة :	المرحلة الاولى/ المعهد التقني
الهدف العام من المحاضرة :	تزويد الطلاب بالمعرفة والفهم والتطبيق والتحليل والتقويم في علم ديناميك الحرارة و الوقود - التعاريف والخصائص والتطبيقات في الغلايات وأنظمة التبريد، الغلايات - أنواعها وخصائصها،
الأهداف السلوكية او مخرجات التعلم:	1 - يتم تقييم فهم الطلاب للمفاهيم الثرموديناميكية من خلال الاختبارات الكتابية التقليدية. 2 - يتم تقييم القدرة على التطبيق في حل المشكلات. 3 - يتم تقييم القدرة على تطبيق المعرفة الرياضية في سياقات العالم الحقيقي. 4- يتم تقييم القدرة على التواصل الفعال للأفكار والمفاهيم الرياضية والمعرفية.
استراتيجيات التيسير المستخدمة	1. المحاضرات 2. التعلم النشط 3. التعلم القائم على المشروع 4. التعلم الذاتي 5. التعلم الرقمي 6. التقييم المستمر
المهارات المكتسبة	سيكون لدى الطالب قابلية التطوير والقدرة على التفكير المنطقي والتحليلي

	والنقدي في حل المشكلات التخصصية في الجانب الحراري والرياضي والهندسي.
طرق القياس المعتمدة	الامتحانات اليومية والشهرية و تكليف الطلاب بمشاريع تتطلب تطبيق المعرفة

The Twenty-Sixth, Twenty-Seventh and Twenty-Eighth Lecture

(Fuel - Definitions, Properties, and Applications in Boilers and Cooling Systems)

Pre-Lecture Questions:

1. What are the main types of fuels used in boilers and cooling systems?
2. How do the properties of fuel affect the efficiency of boilers and cooling systems?
3. What role does fuel play in energy generation and heat transfer processes?

Introduction to Fuel:

Fuel is any material that can be burned or otherwise consumed to produce energy. In the context of mechanical engineering, particularly in refrigeration and air conditioning systems, fuel plays a critical role in providing the necessary energy for heating, cooling, and operating various machinery. Fuels can be categorized into two main types: **fossil fuels** (such as coal, oil, and natural gas) and **renewable fuels** (such as biofuels and hydrogen).

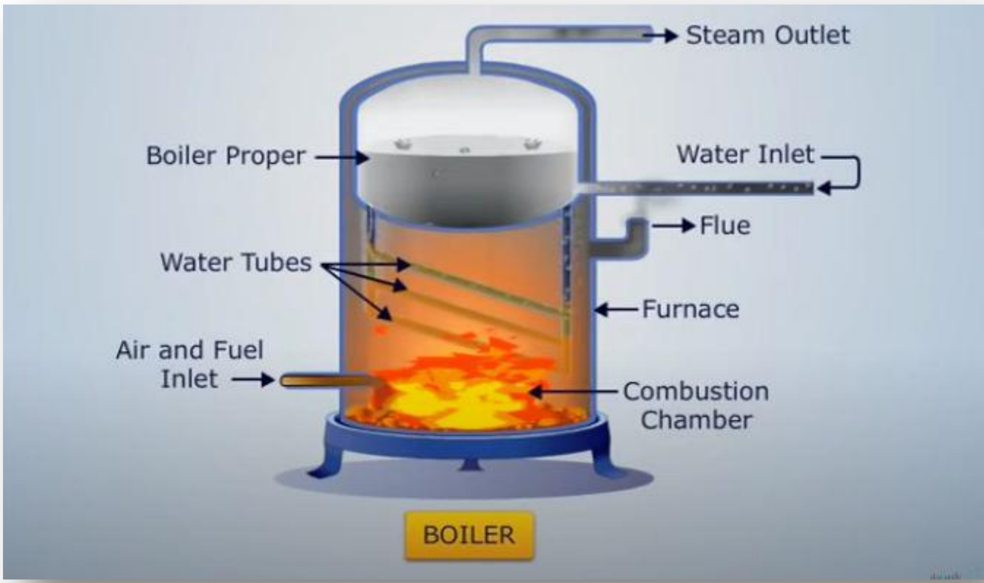
Properties of Fuel:

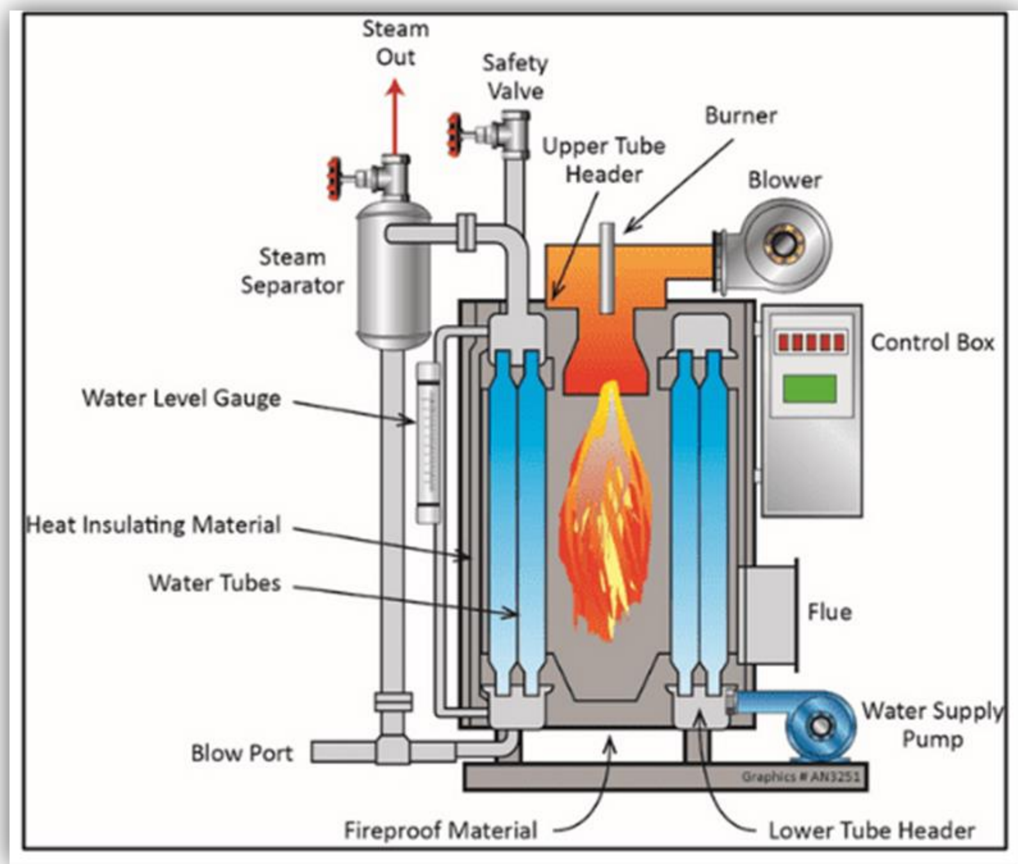
The efficiency and performance of boilers and cooling systems depend significantly on the properties of the fuel used. Key properties include:

1. **Calorific Value:**
   - **Definition:** The amount of energy produced per unit mass or volume of fuel when it is completely burned. It is usually expressed in units such as MJ/kg (megajoules per kilogram) or BTU/lb (British Thermal Units per pound).
   - **Importance:** A higher calorific value indicates a more efficient fuel that can generate more energy for heating or cooling applications.
2. **Viscosity:**
   - **Definition:** A measure of a fluid's resistance to flow. Fuels with lower viscosity are easier to pump and atomize, leading to better combustion.
   - **Importance:** Fuel viscosity affects the efficiency of the combustion process and overall system performance.
3. **Flash Point:**
   - **Definition:** The lowest temperature at which a fuel can vaporize to form an ignitable mixture in air.
   - **Importance:** A lower flash point indicates a higher risk of fire and necessitates special handling precautions.
4. **Density:**
   - **Definition:** The mass of fuel per unit volume, usually expressed in kg/m^3 or g/cm^3.
   - **Importance:** Density affects storage, transportation, and combustion characteristics of the fuel.

Applications of Fuel in Boilers:

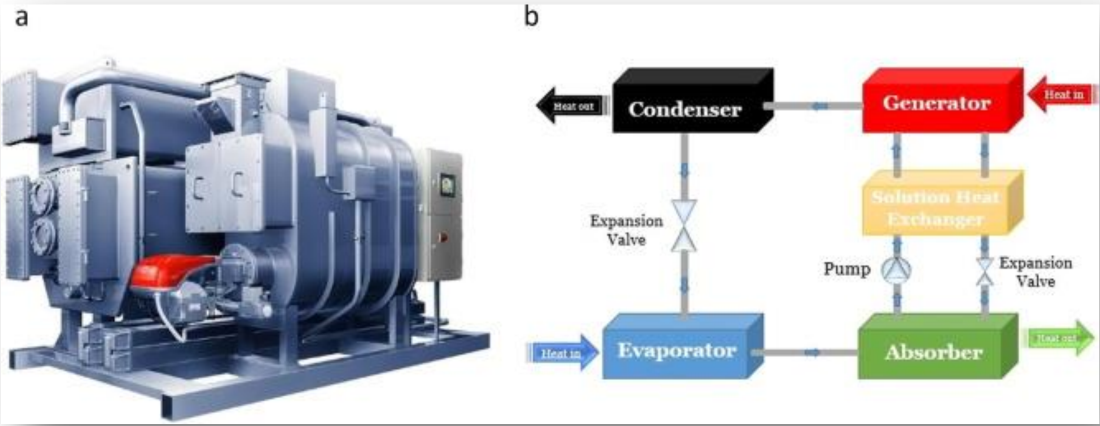
1. **Boiler Operation:**
   - **Description:** In boilers, fuel is burned to produce heat, which is then transferred to water or steam to generate energy. Common fuels include natural gas, fuel oil, and coal.
   - **Efficiency Considerations:** The efficiency of a boiler can be significantly affected by the type of fuel used, its properties, and the combustion system design.
   -





2. **Cooling Systems:**

- **Description:** While cooling systems primarily use electricity, they may rely on fuel-powered generators or absorption chillers that utilize fuels like natural gas or propane for heat-driven cooling applications.
- **Diagram of an Absorption Chiller System:**



Example Problems:

Problem 1:

A boiler operates with fuel oil having a calorific value of 42 MJ/kg. If the boiler consumes 100 kg of fuel oil, calculate the total energy produced.

- **Formula to Solve:**

$$\text{Total Energy} = \text{Fuel Consumed} \times \text{Calorific Value}$$

Problem 2:

If a fuel has a viscosity of 5 cSt (centistokes), determine if it is suitable for use in a specific combustion system that requires a viscosity below 10 cSt.

Post-Lecture Questions:

1. What factors influence the choice of fuel for a boiler or cooling system?
2. How do the properties of fuel impact energy efficiency in heating and cooling applications?
3. Why is it important to monitor the characteristics of fuel used in industrial systems?
4. What safety measures should be considered when handling fuels?

The Twenty-Ninth and Thirtieth Lecture

(Boilers - Types and Characteristics)

Pre-Lecture Questions:

1. What is the primary function of a boiler in mechanical systems?
2. What are the main types of boilers, and how do they differ from each other?
3. How do boiler characteristics influence their efficiency and performance?

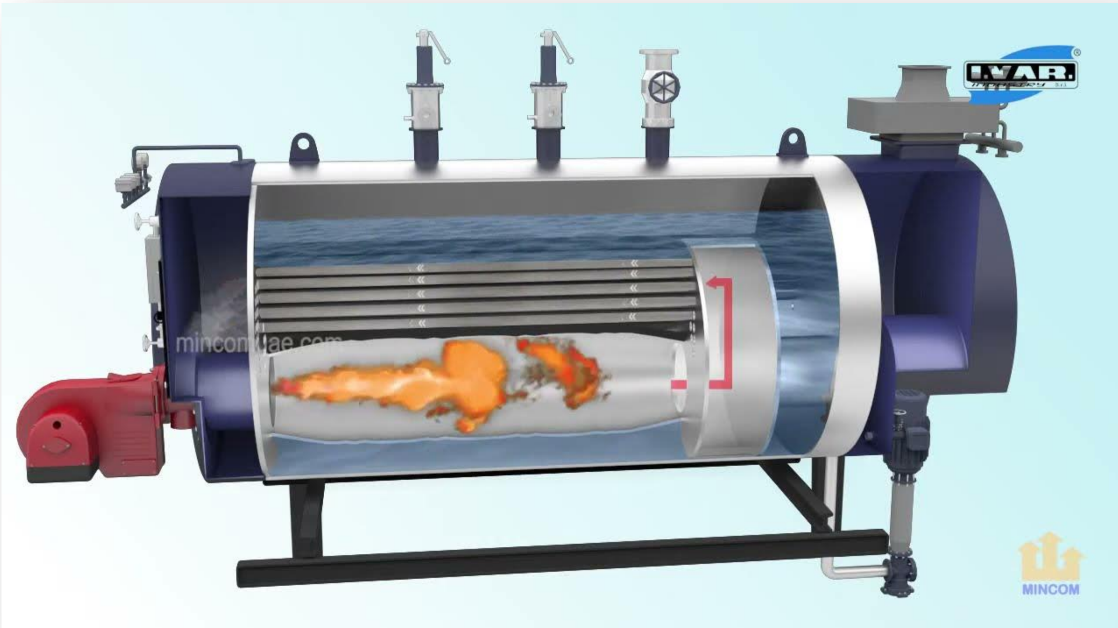
Introduction to Boilers:

A **boiler** is a closed vessel that heats water or other fluids to generate steam or hot water for various applications, including heating, power generation, and industrial processes. Boilers are essential components in mechanical engineering, especially in HVAC (Heating, Ventilation, and Air Conditioning) systems and refrigeration applications.

Types of Boilers:

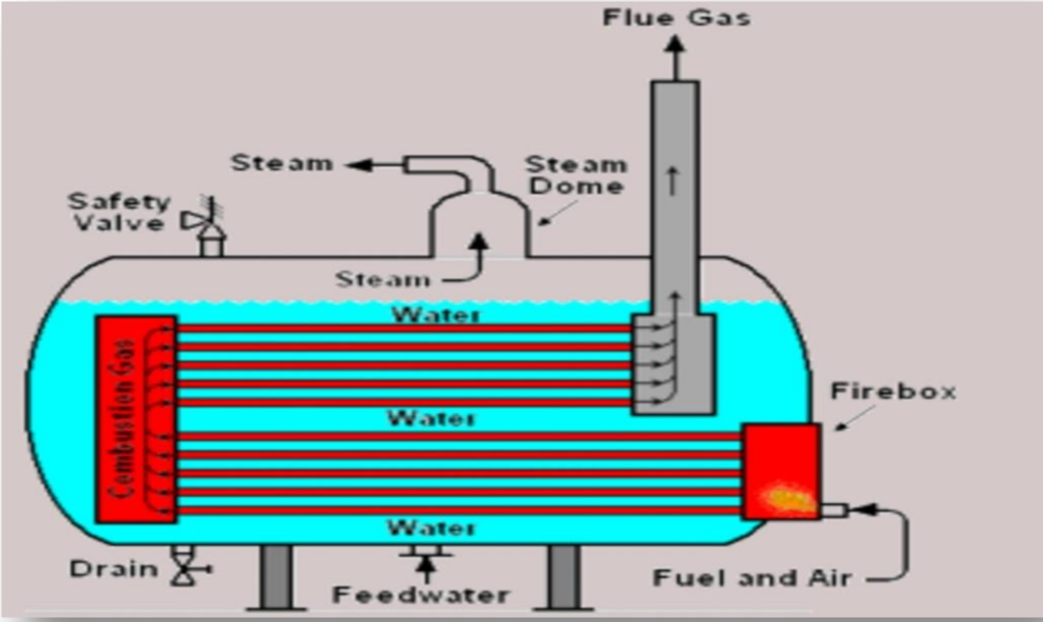
Boilers can be classified into several types based on different criteria:

1. **Fire-Tube Boilers:**
    - **Description:** In fire-tube boilers, hot gases from the combustion process pass through tubes submerged in water. The heat from the gases transfers to the water, generating steam.
    - **Advantages:** Simple design, easy to operate and maintain, and relatively low initial cost.
    - **Applications:** Suitable for low-pressure steam applications and heating.

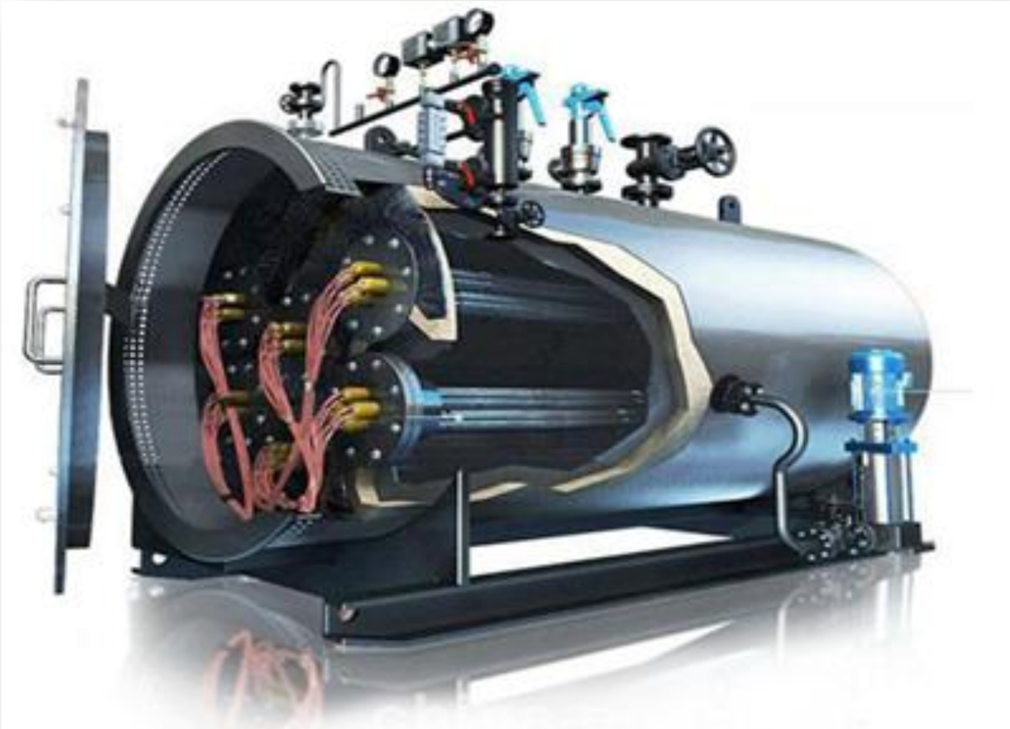


2. **Water-Tube Boilers:**
    - **Description:** Water-tube boilers circulate water through tubes heated by hot gases. The pressure inside the tubes is higher than in fire-tube boilers.
    - **Advantages:** Can produce high-pressure steam, higher efficiency, and faster response to load changes.

- **Applications:** Used in power plants, industrial processes, and high-pressure applications.



3. **Electric Boilers:**
    - **Description:** Electric boilers use electric heating elements to heat water directly. They can be either steam or hot water generators.
    - **Advantages:** High efficiency, low emissions, and compact design.
    - **Applications:** Ideal for smaller applications, residential heating, and areas with limited fuel availability.



4. **Biomass Boilers:**
   - **Description:** Biomass boilers burn organic materials (like wood pellets or agricultural waste) to produce heat.
   - **Advantages:** Renewable energy source, lower carbon emissions compared to fossil fuels.
   - **Applications:** Used in residential heating, industrial applications, and district heating systems.

Characteristics of Boilers:

1. **Efficiency (الكفاءة):**
   - **Definition:** Efficiency refers to the ratio of useful energy output to the energy input. High-efficiency boilers use less fuel to produce the same amount of steam or hot water.
   - **Importance:** Higher efficiency results in lower operational costs and reduced environmental impact.
2. **Pressure Rating:**
   - **Definition:** The maximum pressure a boiler can safely operate under. Common classifications include low-pressure (< 15 psi) and high-pressure (> 15 psi) boilers.
   - **Importance:** Pressure rating affects the type of applications the boiler can serve.
3. **Fuel Type:**
   - **Description:** Boilers can operate on various fuels, including natural gas, oil, coal, and biomass. The choice of fuel affects operational costs and emissions.
   - **Importance:** Different fuels have different combustion properties, which impact boiler design and efficiency.

Example Problems:

Problem 1:

A fire-tube boiler has an efficiency of 85% and produces 10,000 kg of steam per hour. Calculate the fuel consumption if the calorific value of the fuel used is 42 MJ/kg.

- **Formula to Solve:**

$$\text{Fuel Consumption} = \frac{\text{Energy Output}}{\text{Efficiency} \times \text{Calorific Value}}$$

Problem 2:

Determine the pressure rating required for a steam application that operates at 12 psi. Discuss the implications of using a low-pressure versus a high-pressure boiler.

Post-Lecture Questions:

1. What factors should be considered when selecting a boiler for a specific application?
2. How do boiler types influence maintenance requirements and operational costs?
3. What safety considerations are essential for boiler operation?

4. Why is it important to understand the characteristics of boilers in engineering applications?

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1) مصادر اساسية:

- "**Thermodynamics: An Engineering Approach**"لمؤلفيه Yunus Çengel وMichael Boles.
- "**Fundamentals of Thermodynamics**"لمؤلفيه Richard E. Sonntag و Claus Borgnakke وGordon J. Van Wylen.
- "**Introduction to Thermal Systems Engineering**"لمؤلفيه Gordon J. Van Wylen و Richard E. Sonntag.

2) مراجع أكاديمية:

- "**Thermodynamics**"لمؤلفه Howard Reith.
- "**Engineering Thermodynamics**"لمؤلفيه R.K. Rajput.

3) كتب مرجعية إضافية:

- "**Thermodynamics: An Interactive Approach**"لمؤلفه David F. Young.
- "**Thermodynamics**"لمؤلفه W. A. van Wylen.

4) مواقع إلكترونية تعليمية:

- **Coursera** و **edX**: تقدم دورات تعليمية في الديناميكا الحرارية.
- **Khan Academy**: توفر دروسًا شاملة حول المفاهيم الأساسية في الديناميكا الحرارية.

5) **مقالات بحثية:**

- يمكن البحث في المجلات العلمية مثل "Journal of Thermodynamics" و "Applied Thermal Engineering" للحصول على أبحاث ومقالات حديثة.