

Difference Between Subcritical and Supercritical Boiler

www.differencebetween.com

Key Difference - Subcritical vs Supercritical Boiler

Boilers are closed vessels in which a fluid is heated, most of the times, it is water. Even though the name of this is a boiler, the fluid does not necessarily boil in this. The heated fluid is used in various applications including water heating, central heating, cooking, etc. Subcritical and supercritical boilers are such steam generating systems. The **key difference** between a Subcritical and supercritical boiler is that **Subcritical boilers work at a subcritical pressure of the fluid whereas supercritical boilers work at a supercritical pressure of the fluid.**

What is the Critical Point?

The critical point of a substance is the temperature and pressure at which that substance can behave like a [gas and a liquid](#) at the same time, hence indistinguishable gas and liquid phases occur. That is because the [density](#) of the gas phase and the liquid phase is equal at this point. A substance that exists at temperature and pressure, above its critical point is known as a supercritical fluid. A substance that exist below its critical point is known as a subcritical fluid. In a phase equilibrium curve, the critical point is the end point of the curve.

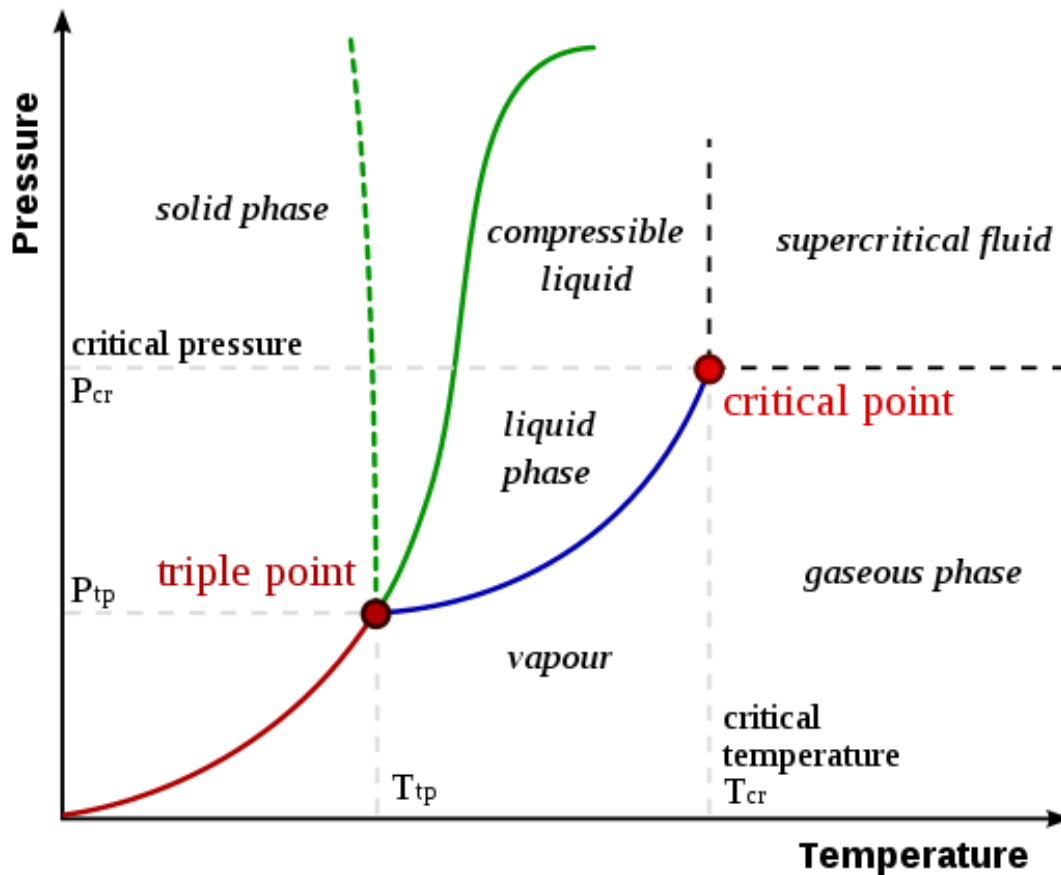


Figure 01: A Phase Diagram showing the Critical Point of Water

The term supercritical in supercritical boilers refers to the pressures above the critical point of water that the boiler is being operated. The critical point of water is at 647 K temperature and 221 bar (22.1 MPa) pressure. Pressures below 221 bar are known as “subcritical pressure” and above 221 bar is “supercritical pressure” of water.

What is a Subcritical Boiler?

Subcritical boilers are boilers that work at temperatures up to 374°C and at a pressure of 3,208 psi (the critical point of water). These boilers compose a system with constant [evaporation](#) endpoint. A typical example for a subcritical boiler is the drum-type steam generator.

Inside the boiler, the natural circulation of the fluid is generated by heating the risers. The water and steam mixture that is leaving this riser is then separated into water and steam in the drum. Water is circulated, water returns to the evaporator inlet through down corners while steam flows into the super-heater chamber.



Figure 02: A Thermal Power Station

If the fluid is allowed to undergo natural circulation, the application range is limited to about 190 bar as the maximum drum pressure. But if the circulation is done using a circulating pump, (known as forced circulation), this range can be extended. This extension happens because of the fixing of the endpoint of evaporation in the drum. And also, it sets the size of the heating surface in the evaporator and in the super-heater. A major drawback of the subcritical boiler is, in these boilers, bubble formation can occur.

What is a Supercritical Boiler?

Supercritical boiler (supercritical steam generator) is a type of boiler that works under supercritical pressure conditions. This type of boilers is often used in generating electricity. Unlike in subcritical boilers, there is no bubble formation in supercritical boilers, and liquid water immediately converts into steam.

Supercritical boiler works at temperatures around 538–565°C and pressures above 3,200 psi. A supercritical boiler has a system with variable evaporation endpoint. These boilers are drum-less. Hence, the evaporation takes place at a single pass through the evaporator. The flow of fluid, most of the times; water, is induced by the feed pump. This makes the system to be operated at any desired pressure, enabling it to operate the system at either subcritical conditions or supercritical conditions. As a result, the evaporation endpoint varies. And also, in order to maintain these conditions, the evaporator and super-heater areas automatically adjust according to the requirements.



Figure 03: A Water Tube Boiler

This boiler is named as supercritical boiler because it is operated above the critical pressure of water which is 221 bar. Since above the critical point, there is no distinction between steam and water, water acts as a fluid.

Beyond the critical point of water, the latent heat of vaporization is zero, and hence there is no considerable distinction between the liquid phase and vapor phase of water. one of the major advantages of supercritical boilers is less fuel consumption. This causes less production of greenhouse gases. and also, due to no bubble formation, less water consumption can be observed.

What are the similarities Between Subcritical and Supercritical Boiler?

- The basic operational mechanism/cycle of both Subcritical and Supercritical Boiler is same.
- Except for the drum-less evaporators in supercritical boilers, other constructional features are also same.
- The techniques of both Subcritical and Supercritical Boiler use similar equipment and strategies in operation. i.e. air preheater, economizer, turbines, condensers, boiler feed pumps, etc.

What is the Difference Between Subcritical and Supercritical Boiler?

Subcritical vs Supercritical Boiler	
Subcritical boilers are boilers that work at temperatures up to 374°C and at a pressure of 3,208 psi (the critical point of water).	Supercritical boiler (supercritical steam generator) is a type of boiler that works under supercritical pressure conditions.
Temperature	
Subcritical boilers are operated at temperatures up to 374°C.	Supercritical boilers are operated at temperatures around 538–565°C.
Pressure	
Subcritical boilers are operated at a pressure of 3,208 psi.	Supercritical boilers are operated at a pressure above 3,200 psi.
Drums	
Subcritical boilers are composed of drums.	Supercritical boilers are drum-less.
Bubble Formation	
Bubble formation is a major drawback in subcritical boilers.	There is no bubble formation supercritical boilers.

Summary - Subcritical vs Supercritical Boiler

Subcritical and supercritical boilers are two forms of steam generators that are used for electricity generation. These are categorized as such, based on their operating conditions. The difference between a Subcritical and supercritical boiler is that Subcritical boilers work at a subcritical pressure of the fluid whereas supercritical boilers work at a supercritical pressure of the fluid.

Reference:

- 1.SHIVAJI CHOUDHURY, CHIEF ENGINEER at M P POWER GENERATING CO,JABALPUR Follow. "Super critical" LinkedIn SlideShare, 21 Aug. 2014. [Available here](#)
- 2."Supercritical steam generator." Wikipedia, Wikimedia Foundation, 11 Feb. 2018. [Available here](#)
- 3."Supercritical boilers." Desein. [Available here](#)

Image Courtesy:

- 1.'Phase-diag2' By Matthieumarechal, [\(CC BY-SA 3.0\)](#) via [Commons Wikimedia](#)
- 2.'NesjavellirPowerPlant edit2'By Gretar Ívarsson – Edited by Firo002 - Gretar Ívarsson, geologist at Nesjavellir, (Public Domain) via [Commons Wikimedia](#)
- 2.'Water tube boiler from Bangladesh'By Sm faysal - Own work, [\(CC BY-SA 3.0\)](#) via [Commons Wikimedia](#)

How to Cite this Article?

APA: Difference Between Subcritical and Supercritical Boiler.(2018 February 19). Retrieved (date), from <http://differencebetween.com/difference-between-subcritical-and-vs-supercritical-boiler/>

MLA: "Difference Between Subcritical and Supercritical Boiler" Difference Between.Com. 19 February 2018. Web.

Chicago: “Difference Between Subcritical and Supercritical Boiler.” Difference Between.Com. <http://differencebetween.com/difference-between-subcritical-and-vs-supercritical-boiler/> accessed (accessed [date]).



Copyright © 2010-2018 Difference Between. All rights reserved