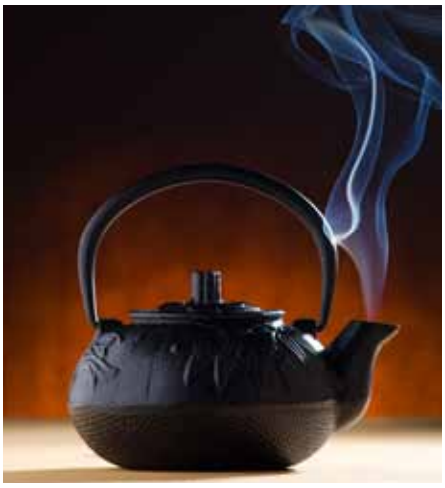
what is steam exactly?

Steam is water which has been changed into a gas. Steam cannot be seen for it is colorless. The cloud of vapor that we see beginning about 2 centimeter from the spout of a teakettle is not steam. The real steam is in the space that seems vacant just outside the spout. The cloud we see is the water that the cooler air has changed from a gas form back into tiny water particles.
Steam is formed by boiling or by evaporation. At sea level water boils when it is heated to 100° C. Water also evaporates at lower temperatures. The steam caused by boiling is as hot as the boiling water. The steam caused by evaporation is not hot. Usually, the word steam refers to hot steam. When water reaches the boiling point, bubbles of the steam begin to rise through it and escape into the air. The temperature will remain at the boiling point until all the liquid has become gas. It requires 100 calories of heat to raise one gram of water from the freezing point (0°C) to the boiling point.
Steam fills more space than the water from which it comes, at the moment when boiling stops, the gas is 1,67 times as great in volume as the former liquid. At this stage it is called saturated steam, if heated more, it takes up even more space. Then it is known as super heated steam. The steam engine is built on this principle.



saturated dry steam

Saturated dry steam will be defined on this page by starting off from common knowledge.

1. We know that substances may exist in various physical forms: solid, liquid, steam. These different forms are called states of substances aggregation. The change from one state to the other is defined with the following words: fusion; vaporization, solidification. We also know that by heating a body, this changes its temperature and its physical state. This happens because the kinetic energy (movement) of the particles which move far away from each other increases, thus loosening the cohesion power. A solid body changes to a liquid state (fusion), and then it goes on until it becomes gas (vaporization). On the other hand, by reducing the temperature, the particles increase their state of aggregation: steam becomes liquid (condensation) and afterwards it solidifies (solidification). Some substances, moreover, may even change directly from a solid state to gas (sublimation) and vice versa (condensation). (Fig.1)

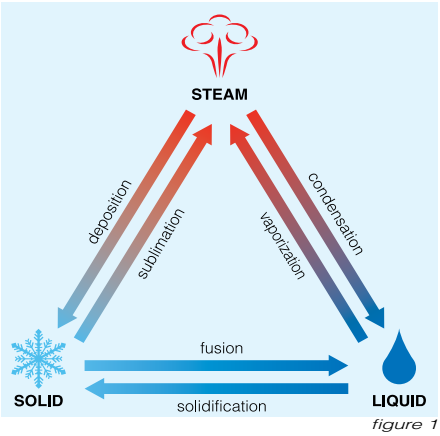


figure 1

2. The three states of water and the change from one state to the other are represented in Fig.2. The vaporization temperature, with a pressure of 1 atmosphere, is 100° C. The phase in which heat is given but there is no water temperature increase is defined as latent heat, in fact, in this phase the given heat is only needed to change the state of water from solid to liquid or from liquid to steam. The latent heat of vaporization is thereafter the quantity of heat needed to transform completely in steam a liquid unitary mass when this is at boiling temperature.
We will now examine in detail the change of phase of 1 kg of water placed in a container with an initial temperature of 5° C and which can maintain a constant pressure at 1 atm. We start to heat the water: the temperature raises and the occupied volume slightly increases, while the pressure remains constant.
a) A few instants before the transformation of part of the liquid into steam begins, the liquid is defined as a saturated liquid, a light increase of heat determines the beginning of the transformation from liquid to steam.
b) When the change from liquid to steam occurs, the temperature and the pressure values are called respectively saturation or vaporization temperature and saturation or vaporization pressure.
c) During the transformation of liquid into steam, the steam is called saturated steam. Here water is still present as micro drops.
d) When all the liquid has been transformed into steam it is called saturated dry steam; all the heat which has been given was used in order to transform the water into steam, no micro drops are present.
e) If heat is still applied, the temperature continues to rise and the steam volume continues to increase. If the pressure is maintained constant, the steam is called superheated steam, because it has a higher temperature than the saturation temperature of 100° C with the specific pressure of 1 atm, which was the pressure the process started off with.

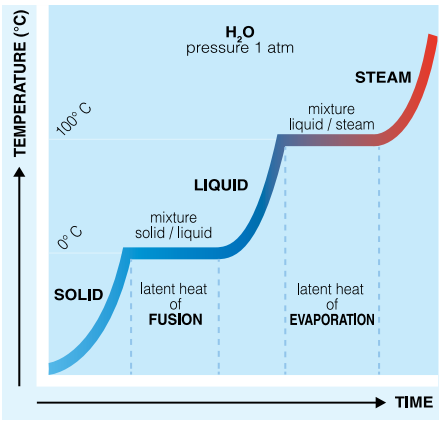


figure 2

3. The vaporization temperature, as we have seen, depends on pressure. The diagram (Fig.3) indicates the vaporization temperatures according to the given pressure.

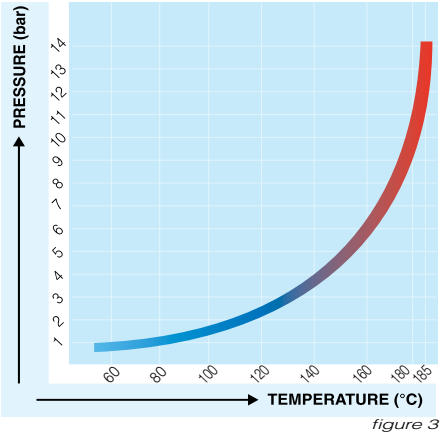


figure 3

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phases from liquid to steam

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The 4 regions of the state of water are:

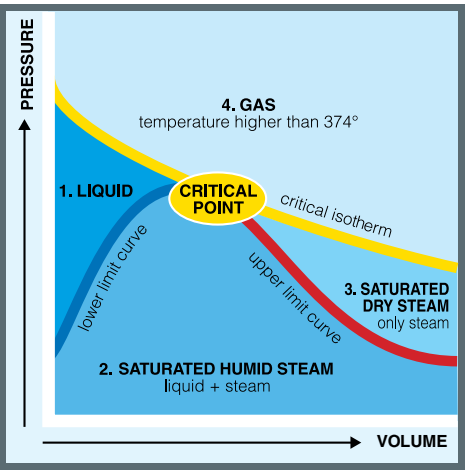
1. Liquid

2. Saturated humid steam, between lower limit curve and upper limit curve, liquid and steam are present at the same time. In this region water is in the vaporization phase if we go from left to right (this happens by giving heat), in the condensation phase if we go from right to left (this happens by decreasing heat). The upper limit curve identifies the points at which saturated dry steam is obtained and it also represents the border line with the superheated steam.

3. Saturated dry steam, included between the upper limit curve and the critical isotherm.

4. Gas, beyond the region of the superheated saturated dry steam, in this region water has a temperature higher than 374 °C.

The most used diagram to represent the phases of state change of the water from liquid to steam is the **Pressure – volume diagram,** made of 3 curves which indicate 4 regions of state of the water.



The 3 curves are:

The lower limit curve: is defined by the points at which vaporization begins.

The upper limit curve: is made up by the points at which vaporization ends.

The critical isotherm: is made up by the points at which the transformation from steam to gas occurs.

The three curves have in common the CRITICAL POINT, in which the conditions for liquid, saturated steam and gas state coexist, therefore a light variation of pressure, volume or temperature may determine the instant change from one state to the other.

the humidity ratio of dry steam

Saturated humid steam is defined as the steam in which water is present at a liquid state as micro drops. In this case the above-mentioned ratio is between 0 and 1.

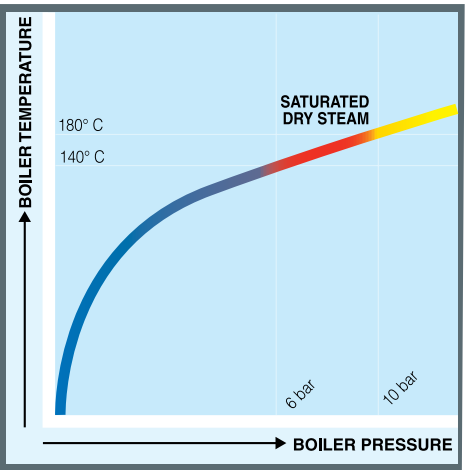
Saturated dry steam is defined as the steam in which no water is present in a liquid state as micro drops. In this case the above mentioned ratio is equal to 1. We might also refer to saturated dry steam when the ratio value is 0.94 - 0.95. In other words, near to 1 even if not equal to 1. Such humidity ratio is obtained with boilers which generate steam at a temperature ranging from 140° to 180° C with a pressure between 6 and 10 bar. In this case the steam contains about 5% micro drops of water.

Such steam has:

- a strong sanitizing power: it kills micro-organisms / bacteria by thermal shock.
- a high cleaning capacity: due to the solvent power of the micro drops of water at a high temperature and to the pressure made on the surface to be cleaned.

Saturated dry steam is therefore a specific state of steam in which no water parts are present; such a situation occurs in the border area between saturated steam and superheated steam. Moreover, we have seen that the physical properties of steam are characterized by the following:

- Pressure
- Temperature
- Volume
- Steam humidity ratio



The humidity ratio is a value which, by varying from 0 to 1, indicates the steam humidity ratio, that is to say, the higher or lower presence of water molecules at a liquid state present in steam.

The humidity ratio is given by the mass ratio between:

$$\frac{\text{dry steam}}{\text{dry steam + liquid water}}$$

the steam phenomenon

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We could say that saturated dry steam is simply steam brought to high temperatures, generally higher than 140° C. At these temperatures, steam has amazing sanitizing and deep cleaning properties. Moreover, it offers ecological advantages such as the possibility to drastically reduce water and detergents consumption. Saturated dry steam is obtained with the aid of boilers operating at a pressure ranging from 6 to 10 bar and temperatures between 140° and 185° centigrade.

When dealing with problems regarding sanitizing and cleaning of simple and complex surfaces, saturated dry steam represents a powerful instrument, since it combines the following natural powers:

- Temperature
- Humidity
- Pressure

Temperature:
High temperature breaks the links between the dirt and the treated surface, killing bacteria and micro-organisms by means of a thermal shock. Moreover, high temperature makes chemical reactions easier by drastically reducing detergents quantity and action time.

Humidity:
Water is called the universal solvent. Even mountains are melted by water. "Dry Steam" contains micro drops of water, which detach the dirt from the treated surfaces, keep it in suspension and avoid letting it into the air.

Pressure:
Although, in this case, pressure does not play a primary role in the cleaning function, it plays a synergic role with the other two factors.

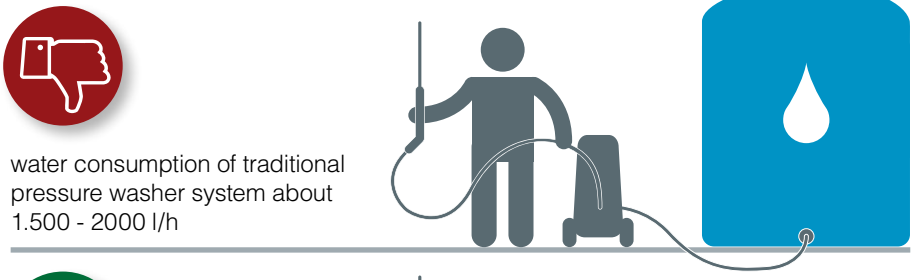
comparing with traditional method

When comparing the phases which characterize the traditional cleaning method with the saturated dry steam procedure, the advantage of the latter is obvious in terms of efficiency. In fact, there are only 3 stages required by saturated dry steam instead of the 6 required by the traditional method.

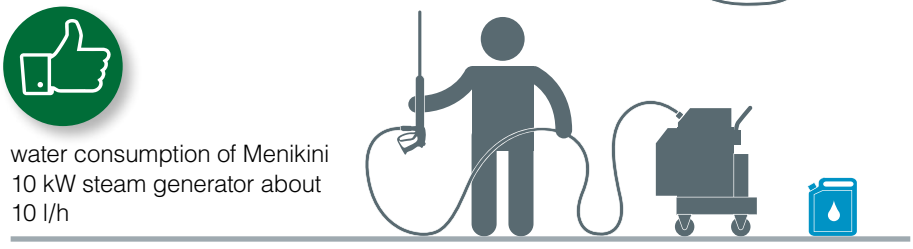
Traditional cleaning
1. Physical removal of solid dirt
2. Pre-wash
3. Clean/wash
4. Rinse
5. Dry
6. Disinfection

Saturated dry steam cleaning
1. Physical removal of solid dirt
2. Clean only with steam
   or steam/water/detergent
3. Dry by removal or absorption

a considerable saving of water



water consumption of traditional pressure washer system about 1.500 - 2000 l/h



water consumption of Menikini 10 kW steam generator about 10 l/h

With reference to efficacy, the cleaning cycle with saturated dry steam compared with the traditional method enables:

1. thermal shock
an efficient sanitizing due to the thermal shock the micro organisms are submitted to, moreover there can be no bacterial adaption to the recurrent use of the chemical agents of the disinfectants.

2. ideal for complex surfaces
a more efficient cleaning of complex surfaces due to the possibility to intervene even in difficult areas which could not be reached by the traditional method.

3. cleaning electric components
the possibility to clean electric panels, electric connections, engine blocks, refrigerators or electronic parts due to the limited presence of micro drops of water in saturated dry steam and to the rapid drying of the surface by means of heat.
NB: Electric panels and machineries must NOT be connected to the mains supply while cleaning operations are carried out. It is suggested to use compressed air before connecting to the mains supply in order to remove any trace of humidity.

4. no surface damage
The surfaces treated with saturated dry steam will not be damaged by thermal shock.

5. save water
A limited consumption of water: about 1 l/h for every kW, versus 1,500 – 2,000 litres/h of water when using water jet machines.

6. environment friendly
A more economical and environmentally friendly technology, in fact the use of detergent is required in only 20% of the cases versus the 100% requirement of the traditional method.

7. no contamination risk
a safe method for the operator who does not risk contamination as with traditional methods, or with low and high pressure bolts of water.

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how to use steam generators

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In order to obtain the best steam production for the type of cleaning or sanitizing activity to be carried out, the following notes should be read carefully:

1) The quality of the steam which comes out from the generator nozzle depends on the temperature to which the steam is brought within the boiler. By quality, we mean the steam humidity ratio. The higher is the temperature, the lower is the steam humidity. That is, we are producing Dry Saturated Steam with a very low percentage of water present (in the form of micro drops). Such Steam has the highest sanitizing power.

2) If the main activity is cleaning rather than sanitizing, it might be necessary to utilize a higher water ratio in order to remove the dirt. Therefore, before cleaning, the boiler temperature can be reduced using the machine's temperature regulator, designed precisely for such purposes, and the amount of water used can be adjusted. The switch for this is conveniently located on the gun of the nozzle.

By engaging the switch, the pump is activated. This withdraws the water from the relevant tank and conveys it to the nozzle where it is mixed with the steam. It is also possible to prepare a mixture of water and detergent instead of just water in the relevant tank. This can facilitate the cleaning of even the most resistant organic or mineral dirt.

3) The distance between the steam output nozzle and the surface to be treated influences the temperature that the steam will have on the surface which it comes into contact with.
The further the distance from the surface, the more steam cooling and thus, the higher the level of steam humidity.

Moreover, the further the distance, the lower the pressure of the steam on the surface to be cleaned.

4) It is possible to resize function, in particular for floors, moquettes, tapestries.

Steam delivery valve: Adjusts the quantity of steam output from the machinery, working exactly like a water tap. When turned towards the minus sign, the steam output is decreased. When turned towards the plus sign, the steam quantity is increased. When the surfaces to be treated are small or for a reduced risk of condensation on the treated surface it is recommended to reduce the quantity of steam output.

Regulation of boiler temperature:
By decreasing the temperature, the saturated steam is more humid. For cleaning activities it may be useful, but not necessary, to reduce temperature. However, it should be kept in mind that in order to carry out sanitizing operations, saturated dry steam, and therefore a high temperature, is required.

gum removal

Steam cleaners feature special chewing gum removal components, including a steam vac squeegee with a stainless steel brush.

The chewing gum removal accessories are effective for a variety of hard surface cleaning including: concrete, cement, sidewalks, parking lots, pavers, walkways and some indoor floors.
Though steam pressure washers can also perform chewing gum removal, the machines expel large amounts of water and are not practical for many applications, particularly indoors.

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