MYTHS vs REALITY

Is it true that Vaporized Hydrogen Peroxide can't replace Saturated Steam sterilization unless the product is incompatible with heat ?

Short Answer:

👉 FALSE.

That statement is **an incorrect oversimplification**, very widespread, but **not correct from a regulatory standpoint**.

What the Regulations DO NOT Say

No international regulation (EU GMP, FDA, ISO) states that:

> "you must use saturated steam and you can only use H_2O_2 if the product is incompatible with heat".

This phrase does not exist in regulatory texts.

DE LAMA HyPerPure® H_2O_2 sterilization under deep vacuum & zero air

DE LAMA

Process & Sterilization Solutions since 1949

VH2O2 Sterilization as an alternative to Saturated Steam

What the Regulations Actually Say

The regulations instead state that:

👉 **the sterilization technology must be:**

- scientifically justified
- appropriate for the product
- validated
- reproducible
- capable of guaranteeing the required SAL (typically 10^{-6})

The Key Principle Is:

risk-based approach + scientific rationale, not a hierarchy of "steam > everything else".

DE LAMA HyPerPure®
H_2O_2 sterilization under deep vacuum & zero air

DE LAMA
Process & Sterilization Solutions since 1949

VH2O2 Sterilization as an alternative to...

Why Steam Is Often Used

Saturated steam is:

the **most historical** technology

very **robust &**

well known by inspectors and companies

👉 For this reason **it is often chosen as the "default"**, **not because it is legally mandatory**.

SATURATED STEAM STERILIZER

DE LAMA HyPerPure® H_2O_2 sterilization under deep vacuum & zero air

DE LAMA
Process & Sterilization Solutions since 1949

When (and Why) vH_2O_2 Can Be Used

Hydrogen peroxide sterilization is **fully accepted** if:

- the process is **validated as sterilization** (not simple decontamination)
- it demonstrates **LOG-6 (or higher) at every point in the load**
- it is supported by:
  - microbiological studies
  - penetration studies
  - worst-case scenarios
  - repeatability
  - material & packaging compatibility

👉 **There is no need to first demonstrate that the product "cannot withstand heat"**. You need to demonstrate that **the chosen process is the best and most controllable for the product**.

The Real Misunderstanding (Very Common)

Many people confuse:

1. VH_2O_2 for decontamination (superficial sterilization)
   (pass-boxes, isolators)
2. VH_2O_2 for actual sterilization with deep vacuum and zero air
   (validated terminal process)

⚠️ Regulations **are justifiably strict** about decontamination being passed off as sterilization.

👉 But **if the VH_2O_2 process is truly sterilizing and validated**, **it is regulatorily acceptable**.

DE LAMA HyPerPure®
H_2O_2 sterilization under deep vacuum & zero air

DE LAMA
Process & Sterilization Solutions since 1949

Clear Summary for Audits and Discussions

❌ **FALSE**

"Steam is mandatory except for incompatibility"

✅ **TRUE**

"Technology must be chosen based on risk, product and process"

✅ **TRUE**

"Vaporized H_2O_2 under deep vacuum sterilization can be used as a first choice"

❌ **FALSE**

"Vaporized H_2O_2 is only a fallback"

Doesn't the new EU Annex 1 support that it is necessary to use saturated steam sterilization unless there are compatibility problems with the products to be sterilized with heat ?

ANSWER: FALSE!

Regulatory answer on Annex 1 (EU GMP 2022)

📌 **There is no sentence in the text of Annex 1 that says "saturated steam sterilization is mandatory unless the product is incompatible with heat" in an absolute and regulatory manner.**

🔍 What the New EU GMP Annex 1 (2022) Actually Says

The document does not prescribe a single sterilization method for all cases.

The text guides the industry to **choose the appropriate method based on risk logic, scientific understanding of the process, and validation consistent with the nature of the load to be sterilized**.

📌 The Role of Steam (Moist Heat)

In the new Annex 1:

✅ Sterilization with **moisture and heat (moist heat)** is highlighted because it represents **a consolidated and well-understood technology**, with robust control criteria (air removal, steam penetration, T-t-p parameters, etc.).

Annex 1 in paragraph 8.37 writes:

> *Particular attention should be given when the adopted product sterilisation method is not described in the current edition of the Pharmacopoeia, or when it is used for a product which is not a simple aqueous solution. Where possible, heat sterilisation is the method of choice.*

📌 So Annex 1, encourages the use of heat sterilization, but does not define it as "mandatory for all materials".

In fact in paragraph 8.35 new Annex 1 writes :

> ***8.35*** *The selection, design and location of the equipment and cycle/programme used for sterilisation should be based on scientific principles and data which demonstrate repeatability and reliability of the sterilisation process. All parameters should be defined, and where critical, these should be controlled, monitored and recorded.*
>
> ***8.36*** *All sterilisation processes should be validated. Validation studies should take into account the product composition, storage conditions and maximum time between the start of the preparation of a product or material to be sterilised and its sterilisation. Before any sterilisation process is adopted, its suitability for the product and equipment, and its efficacy in consistently achieving the desired sterilising conditions in all parts of each type of load to be processed should be validated notably by physical measurements and where appropriate by Biological Indicators (BI). For effective sterilisation, the whole of the product, and surfaces of equipment and components should be subject to the required treatment and the process should be designed to ensure that this is achieved.*

This paragaph above clarifes that processes different than saturated steam are fully contemplated.

Even within the same section on moist heat, the document:

- **recognizes that different moisture/heat modalities can be used** (e.g., steam-air mixtures, superheated water), not necessarily only saturated steam.

💡 The Choice Is Risk-Based and Scientifically Justified

The standard requires that the choice of sterilization method be based on:

✔ Risk Assessment

for the product, process and sterilization cycle

✔ Scientific Understanding

of the method and its limitations

✔ DEFINITION MATTER !

Sterilisation is a suitably designed, validated and controlled process that inactivates or removes viable microorganisms in a product until sterility is obtained (EMA Guideline on sterilization, 2015)

👉 **So we are not talking about "a priori exclusion of a method"**, but about:

- selecting the most appropriate method,
- scientifically justifying it,
- and validating it with robust data.

🧪 Hydrogen Peroxide as an Alternative Technology

The text of Annex 1 **does not prohibit methods other than steam**, such as:

- vapor sterilization with hydrogen peroxide (vH_2O_2),
- other chemical or physical methods if scientifically adequate and validated,
- sterilizing filtration, etc.

These technologies are **acceptable** if the process is properly validated and integrated into a Contamination Control Strategy (CCS).

DE LAMA HyPerPure®
H_2O_2 sterilization under deep vacuum & zero air

DE LAMA
Process & Sterilization Solutions since 1949

🔑 Regulatory Conclusion

➡️ The new EU GMP Annex 1 does not impose a regulatory obligation to use saturated steam in all cases.

➡️ Sterilization must be chosen based on:

- risk assessment,
- scientific equivalence or better performance,
- and demonstrated validation.

➡️ The only "preference" indicated in the text (as in all modern GMPs) is for consolidated and well-understood methods, but not an absolute prohibition of other technologies

📊 Real-World Case History: Patheon by ThermoFisher

Choosing VH_2O_2 as an alternative to Saturated Steam for Sustainability, Not Just Compatibility

Event: PDA Italy Chapter at Merck Bari (October 1-2nd 2025)

Presentation: "Sustainable Choice to Bring-in HyperPure® H_2O_2 Green Sterilization to Reduce Water and Energy Consumption: a case study"

Speakers: Sara Ferretti (Patheon by ThermoFisher) & Andrea Muggiasca (De Lama)

Key Decision: Patheon by ThermoFisher invested in multiple De Lama combo units (Saturated Steam + Vaporized H_2O_2 sterilization)

Results achieved with VH_2O_2 by Patheon by Thermofisher

- 70% reduction in energy consumption
- 70% reduction in CO_2 emissions
- 100% reduction in water consumption

DE LAMA HyPerPure® H_2O_2 sterilization under deep vacuum & zero air

DE LAMA
Process & Sterilization Solutions since 1949

This demonstrates that vH_2O_2 can be chosen as a PRIMARY option as an alternative to Saturated Steam for environmental and sustainability reasons—not just as a fallback for heat-incompatible products.

Thermofisher choice: HyperPure® H_2O_2 tech.

HyperPure® sterilizer sull under start-uopby Thermofisher: Strategic Transfer from Steam Sterilization to **H_2O_2 sterilization technology** is under definitition

DE LAMA HyPerPure® H_2O_2 sterilization under deep vacuum & zero air

DE LAMA
Process & Sterilization Solutions since 1949