The Advantages of Stimulating a Well with 95% High Quality Steam

Introduction:

Steam Injection is a technique aimed at heating the reservoir to lower the viscosity of crude oil and improve its mobility. **The quality of steam**, which is defined as percentage of saturated dry steam vapor in the total steam-liquid mass, plays a crucial role in achieving optimal recovery results.

The industry conventional standard OTSG is to generate high-pressure 80% and 20% saturated liquid condensate. The purpose of generating wet steam is to eliminate dissolved precipitated salts in the water along with the steam since there is no other method for removing these salts during steam generation, as seen in drum-type boilers. Failure to remove these salts can lead to clogs in the pipes, reducing heat transfer efficiency and increasing the risk of pipe ruptures. The traditional method of producing 80% high-quality steam for oil recovery operations leads to significant water and fuel losses, raising operating costs and being environmentally unfavorable.

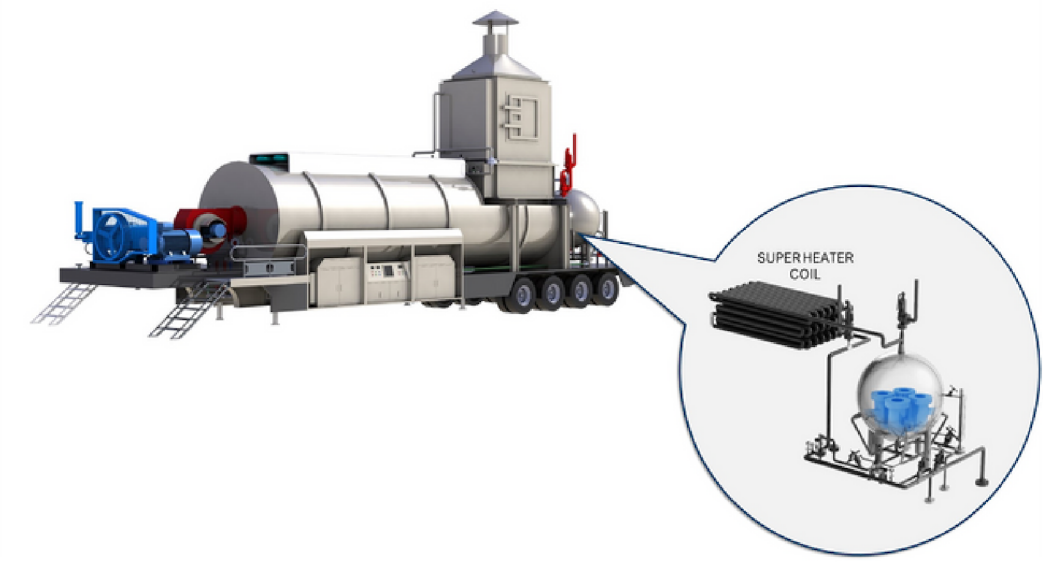
For a typical conventional 25MMBTU/h OTSG (350 BCWEPD) operating @2500 Psig pressure, achieving 80% quality dry steam installing a separator at the outlet will amount to loss per day:

- 55,680 Liters of precious treated water
- 1,950 kg of LPG Fuel

The Nakasawa Approach - Super Matroid Technology

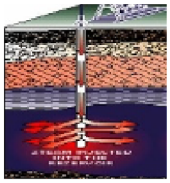
Maximizing Profitability with Low Operational Costs and High Oil Yields

Overcoming steam quality challenges is essential for maximizing efficiency and increasing oil recovery rates. *Nakasawa Super Matroid Technology* **(SMT)** produces 95% - 98% quality steam without any wastage of water or fuel. All the heat absorbed by the steam in the boiler is injected into the well, improving oil recovery effectiveness and reducing operational costs.



Nakasawa has developed an environmentally friendly **SMT** which generates 95% high quality steam using standard treated soft feed-water without any need of separating liquid at the outlet of the steam generator as conventionally done by other operators in the field. The Super Matroid Technology uses 12% less water to deliver the same amount of heat generated by a conventional OTSG to the well and additionally eliminates loss of 15% fuel.

Benefits of 95% Steam Quality:

	**Heat Transfer:** The quality of steam used in an oil reservoir greatly impacts heat transfer efficiency. High-quality steam enhances heat transfer, reducing oil viscosity and improving fluid mobility, ultimately leading to higher oil recovery rates.
	**Hydration and Corrosion Prevention:** Poor steam quality can result in hydration problems, leading to formation damage and decreased oil recovery. Steam containing impurities and of low quality can cause corrosion in wellbores and surface equipment. Using high-quality steam helps mitigate damage to well integrity and improves overall reservoir performance.
	**Steam Trapping:** Poor-quality steam can lead to condensate accumulation, disrupting heat transfer. Maintaining high steam quality minimizes steam trapping, facilitating even steam distribution in the reservoir for better performance.
	**Distribution Line Heat Loss:** Steam distribution pipes, even when insulated, experience some ambient heat loss, which can lower steam quality. Traditional steam generators produce steam at around 80% dryness, but it may drop to 75-77% by the time it reaches the well. To optimize enhanced oil recovery, it is crucial to generate steam at the source with a dryness level of 95-98% to maintain steam quality between 92-94% at distant wells.

The Recovery Factor at 95% vs 80% Quality Steam

While the traditional approach of 80% steam quality has been a prevalent method in enhanced oil recovery, it falls short when compared to the modern techniques harnessing a 95% steam quality.

An analysis of the provided data on production showcases a significant advantage of the 95% steam injection method. When the wells were stimulated with 95% high-quality steam, an impressive average incremental production of about 420% was observed. This suggests that the oil recovery rate drastically improved with the higher steam quality.

Comparatively, if we were to hypothetically assess the recovery rate at 80% steam quality and factor in the conventional losses and inefficiencies associated with this quality, we could infer a decreased recovery factor. Drawing from the analysis and given that we've recorded a 420% increase at 95% quality, a conservative estimate might peg the recovery at 80% steam quality to be around 280% - 300%, thereby translating to an estimated loss of about 120% - 140% in recovery potential.

The marked difference in these percentages speaks volumes about the benefits of opting for the 95% steam quality. It offers a pronounced increase in oil recovery, significantly reduces operational costs and potential challenges associated with corrosion, hydration, and uneven steam distribution. In conclusion, for maximum oil recovery efficiency and optimization of resources, utilizing 95% high-quality steam emerges as the evident choice.

Criteria	80% Steam Quality	95% Steam Quality
Average Incremental Production	Approx. 280% - 300%	Approx. 420%
Operational Costs	$15k/day	$15k/day
Corrosion Risk	Higher Risk	Significantly Reduced
Hydration Problems	Likely	Minimized
Steam Distribution Efficiency	Uneven Distribution	Even and Optimized
Heat Transfer Efficiency	Reduced	Enhanced
Resource Utilization	More Water & Fuel used	12% Less Water, 15% Less Fuel
Well Productivity	Potential Challenges	Optimized for Maximum Recovery
Environmental Impact	Larger Carbon Footprint	Reduced Emissions

Environmental Impact of (SMT) Combustion System

Nakasawa incorporates a high-efficiency burner, equipped with precise fuel-air control mechanisms and VFD controls by software ensure complete combustion. This high efficiency burner effectively reduces the emission of greenhouse gases, contributing to a more environmentally friendly operation.

Nakasawa 25MMBtu/hr Exhaust Gas Emission from the combustion using Natural Gas as fuel

- **Carbon Dioxide (CO2) Emissions:**

The CO2 emissions are 8.08 Mol% or 3,699 Lbs/h.
This is a critical metric since CO2 is a major greenhouse gas. The value seems typical for natural gas combustion, given that it primarily consists of methane which, when burned, produces CO2 and H2O as the main products.

- **Oxygen (O2) Content:**

The O2 content in the exhaust is 3.14 Mol%.
The O2 content indicates a complete combustion process since a small percentage of excess oxygen is present in the flue gas.

- **NOx Emissions:**

The emissions are less than 10 PPM, which is low. NOx emissions are environmental concerns due to their contribution to smog and acid rain. It is good to see that the emissions are on the lower side.

- **Water Vapor (H2O):**

H2O content is expected from natural gas combustion since methane (the primary component of natural gas) produces water when burned.

- **Absence of SO2:**

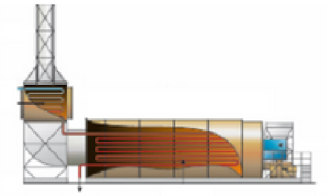
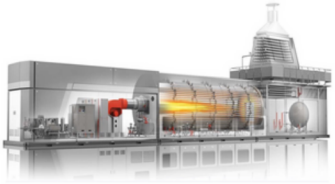
There is no SO2 emission, which is expected since natural gas is a cleaner fuel and contains very little sulfur compared to other fossil fuels.

- **Fuel Efficiency:**

The system is operating at 90% fuel efficiency, which is quite efficient.

The Super Matroid Technology by Nakasawa, emits less CO2 in the atmosphere by using less fuel to generate the same amount of dry steam generated by conventional 80% quality steam generator.

CONVENTIONAL OTSG vs NAKASAWA SMT

CRITERIA	 CONVENTIONAL OTSG	 NAKASAWA SMT
Operational Efficiency	Uses a basic burner with rudimentary controls, potentially not ensuring complete combustion.	Uses the General Italia burner with precise software controlled VFD, ensuring complete combustion across all operational ranges.
Steam Quality	Produces 80% dryness steam, which can degrade to 75-77% by the time it reaches the well.	Produces 95-98% quality steam, ensuring 92-94% quality even at distant wells.
Environmental Impact	Might emit more greenhouse gases and requires more water and fuel due to lower steam quality.	Reduces greenhouse gas emissions with its high-efficiency burner. Uses less water and fuel due to higher steam quality.
Resource Utilization	80% steam leads to a daily loss of 55,680 Liters of water and 1,950 kg of LPG fuel.	Uses 12% less water and eliminates 15% of the fuel loss compared to conventional OTSG.
Well Productivity	Potential for hydration problems, corrosion, and uneven steam distribution, leading to lower recovery.	High steam quality ensures optimal heat transfer, reduced corrosion risk, and even steam distribution, maximizing oil recovery.
Future Compliance	Might face challenges with increasing environmental regulations and sustainability emphasis.	Prioritizes environmental friendliness and resource efficiency, aligning with future regulations and ensuring long-term sustainability.