How to measure Antifoaming agents' effectiveness with FOAMSCAN™

INTRODUCTION

Although liquid foams are thermodynamically unstable, under practical conditions they can remain stable for long periods, often creating significant challenges across various industries such as paper manufacturing, pharmaceuticals, food and beverages, coatings, paints, cleaning, crude oil processing, lubrication, and fuel production. Foam must often be suppressed or eliminated to improve process efficiency, for example, to increase storage capacity in vessels (e.g., beer tanks) or to enhance the performance of distillation and evaporation systems.

To achieve low foamability or low foam stability, specific additives are used to either prevent or destroy foam formation:

- Antifoam agents are pre-dispersed in the foaming liquid before processing to inhibit foam generation.
- Defoamers are applied directly to the foam surface to collapse existing stable foams through a rapid "shock" effect.

Common antifoaming substances include insoluble oils, polydimethylsiloxanes (PDMS) and other silicones, alcohols, stearates, and glycols.

Given their impact on process efficiency, it is essential for industries to measure and control the effectiveness of antifoam and defoamer additives by comparing foamability and foam stability in their presence and absence under controlled test conditions.

METHOD

An antifoaming agent that we will call **Defoamer X** was evaluated at four concentrations: 25 ppm (0.025 g/L), 125 ppm (0.125 g/L), 250 ppm (0.25 g/L), and 500 ppm (0.5 g/L), in surfactants solutions.
The antifoam additive was pre-dispersed in two different surfactant solutions:

- **Rhodafac® RE 610**, 8 g/L in water (CAS n° 68412-53-3): a phosphate ester of nonylphenol ethoxylate with a molecular weight of 696 g/mol.
- **Pluronic® F127**, 2 g/L in water (CAS n° 9003-11-6): a nonionic EO/PO/EO triblock copolymer with a molecular weight of 12600 g/mol

The critical micelle concentration (CMC) of Rhodafac® RE 610 is **0.009 g/L**, whereas that of Pluronic® F127 is **0.23 g/L**. Consequently, the Rhodafac® RE 610 solution corresponds to approximately **889 × CMC**, while the Pluronic® F127 solution corresponds to **8.7 × CMC**. Meaning the Rhodafac® RE 610 solution contained roughly 100 times more micelles than the Pluronic® F127 solution.

For each surfactant solution, six measurements were performed in triplicate to ensure statistical reliability.

A final measurement **without defoamer** was performed to verify the **complete cleanliness of the equipment** after the automatic cleaning cycle, thereby confirming the **full reproducibility and reliability** of the measurements.

# 1	Rhodafac® without Defoamer X	Pluronic® without Defoamer X
# 2	Rhodafac® + Defoamer X 25 ppm	Pluronic® + Defoamer X 25 ppm
# 3	Rhodafac® + Defoamer X 125 ppm	Pluronic® + Defoamer X 125 ppm
# 4	Rhodafac® + Defoamer X 250 ppm	Pluronic® + Defoamer X 250 ppm
# 5	Rhodafac® + Defoamer X 500 ppm	Pluronic® + Defoamer X 500 ppm
# 6	Rhodafac® without Defoamer X	Pluronic® without Defoamer X

MEASUREMENT SETTINGS AND PROTOCOL

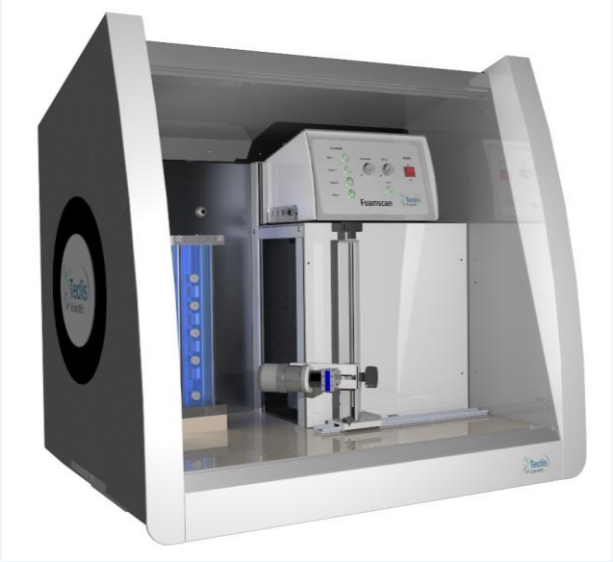
FOAMSCAN™ was used to generate the foam by gas sparging. The foam time was set until the targeted volume of foam is reached (Protocol2).

⇨ The **antifoam effectiveness on foamability** was evaluated by comparing the **time required** for each sample to reach the foam volume objective.

⇨ The **antifoam effectiveness on foam stability** was determined from the **foam half-lifetime**, defined as the time required for the foam volume to decrease by **50%**.

FOAMSCAN™ settings

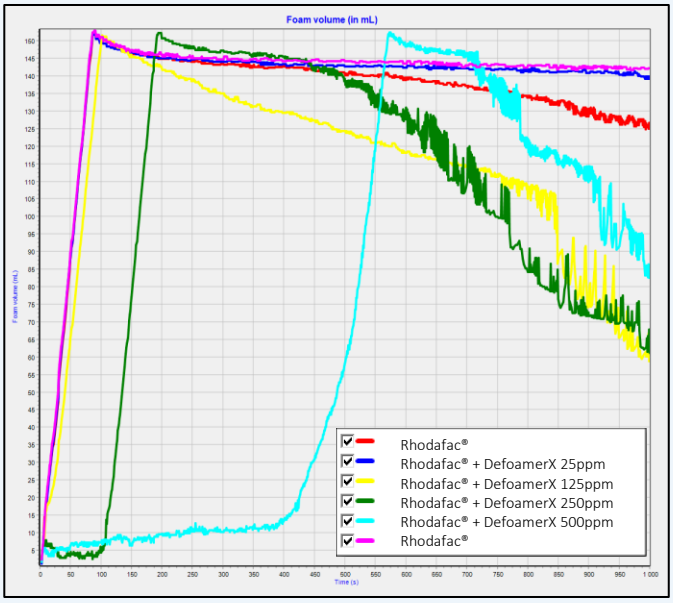
- Foam volume objective = 150 mL
- Gas = Air
- Sample liquid volume = 60 mL
- Gas flow rate F = 100 mL/min
- Glass Frit porosity = P2 (16-40 µm)
- T°= 23 ± 2 °C (Room T°)
- Automatic cleaning cycle performed between each measurement



RESULTS FOR Rhodafac® RE 610

The **foaming time** illustrates the effect of **Defoamer X** on the **foamability** of the **Rhodafac® RE 610** solution as a function of concentration, while the **foam volume half-life** reflects its impact on **foam stability**.

At concentrations **below 125 ppm**, Defoamer X shows **no significant effect** on either foam formation or stability. From **125 ppm onward**, increasing Defoamer X concentration to **250 ppm** and **500 ppm** results in a **longer foaming time** (reduced foamability) and a **shorter foam half-life** (faster foam decay). However, even at **500 ppm**, the additive does **not completely suppress** foam generation or persistence.



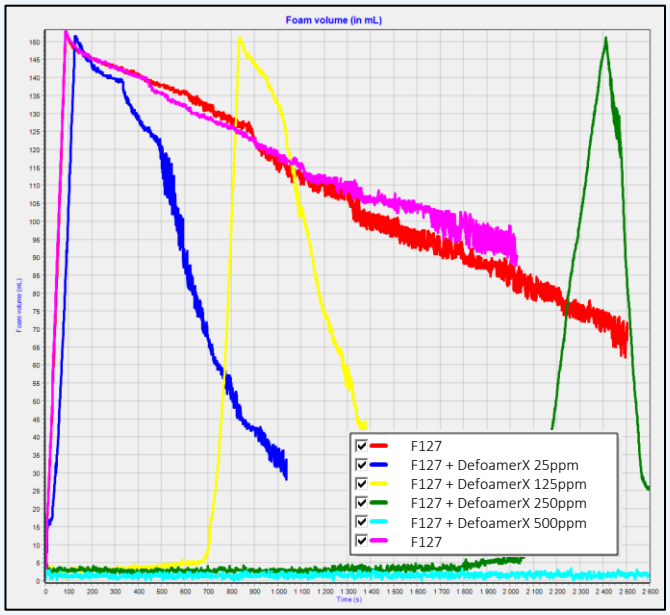
	Defoamer X concentration in the solution					
Rhodafac® RE 610	0 ppm	25 ppm	125 ppm	250 ppm	500 ppm	0 ppm
Foam volume objective (mL)	150	150	150	150	150	150
Initial liquid volume (mL)	59	59,7	58,7	59,6	58,6	58,8
Time of foaming (sec)	86	85	101	191	570	85
Foam volume ½ lifetime (sec)	NA	NA	788	661	465	0

RESULTS FOR Pluronic® F127

The **foaming time** highlights the effect of **Defoamer X** on the **foamability** of the **Pluronic® F127** solution as a function of concentration, while the **foam volume half-life** indicates its influence on **foam stability**.

Defoamer X is effective from **25 ppm**, reducing both foam formation and stability. Its efficiency clearly **increases with concentration**, leading to a progressive delay in foam generation and faster foam collapse.

At **500 ppm**, Defoamer X is **nearly 100% effective**, as foam formation is delayed for approximately **16,000 seconds** (beyond the time window displayed on this graph).



	Defoamer X concentration in the solution					
Pluronic® F127	0 ppm	25 ppm	125 ppm	250 ppm	500 ppm	0 ppm
Foam volume objective (mL)	150	150	150	150	150	150
Initial liquid volume (mL)	57,4	57,6	56,7	56,8	55,8	56,8
Time of foaming (sec)	87	128	834	2412	NA	86
Foam volume ½ lifetime (sec)	2135	523	361	102	NA	2213

CONCLUSION

In this study, **Defoamer X** proved to be **more effective** in the **Pluronic® F127** solution than in the **Rhodafac® RE 610** solution. However, in both systems, the additive does not reduce the foam growth rate once foaming begins but rather **delays the onset of foam formation**.

The **FOAMSCAN™ Protocol 2** has shown to be particularly relevant for assessing the **performance of pre-dispersed antifoams** in surfactant solutions, as it provides key quantitative parameters for evaluating **foamability** and **foam stability**.

Furthermore, the **fully software-controlled protocol** combined with the **automatic cleaning cycle** ensures **excellent measurement reproducibility** and eliminates the need for manual cleaning, making **FOAMSCAN™** a highly reliable and time-efficient instrument for foam analysis.