

Understanding the fouling mechanisms in evaporators by microscopic and microfluidic approach



Margot GROSTETE



Ph.D. fellowship

2022-2025



UMR INRAE – L'Institut Agro
Rennes - Angers

Science et technologie
du lait et de l'œuf

PSF team

Process - Structure - Functionality

Keywords

Fouling, Evaporator, Whey
proteins, Aggregation, Shear rate,
Microfluidics

Funding



Collaborators



DI
C
Ma
PI

Dipartimento
di Ingegneria Chimica,
dei Materiali e della
Produzione Industriale
Università degli Studi
di Napoli Federico II



Socio-economic context

Evaporators are largely used in dairy industry, especially in the powder production process

Fouling leads to :

- Loss of thermal efficiency and pressure drop (During treatment)
- Significant use of water/chemical products for an efficient cleaning and to avoid biofilms formation risk (Indirectly)

Scientific context

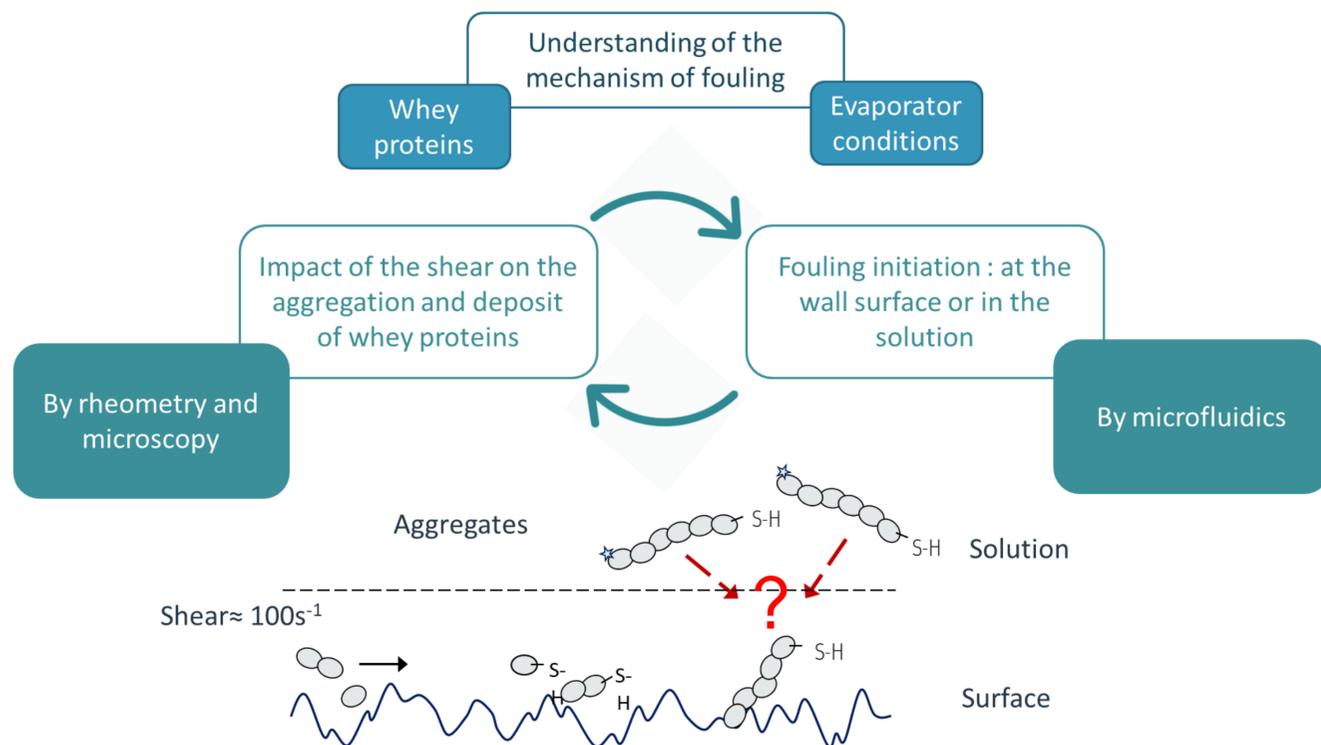
- Fouling was studied in heat exchangers but not in evaporator conditions.
- Fouling mechanisms are complicated to understand because of complex interactions at the microscale.



Different protein aggregates forming in the solution and on the surface

Research question

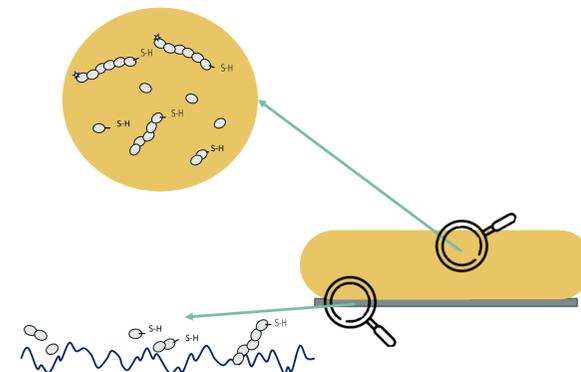
Understanding the surface and solution aggregation and its role on fouling



Expected results

Rheometry and microscopy: Evaluation of the impact of the shear rate

- **Solution** analyses:
 - HPLC = Denaturation degree
 - Rheological behavior of the whey proteins solutions after treatment
 - Fluorescence optical microscopy
- **Surface** analyses :
 - Digital microscopy = Quantitative analyses on the aggregates
 - SEM = Qualitative analyses on the morphology of the aggregates



Microfluidics: Initiation of the fouling

- **Continuous system** = analyses online and offline
- **Surface materials** glass (microscopy) and stainless steel
- Closer of **evaporator conditions**

Perspectives

- Original methodology with rheometer to simulate process conditions and compare surface and solution aggregation
- Microfluidics: innovative biomimetic method adapted to the food process
- Understanding the fouling mechanisms will be a key to limit the deposit before cleaning