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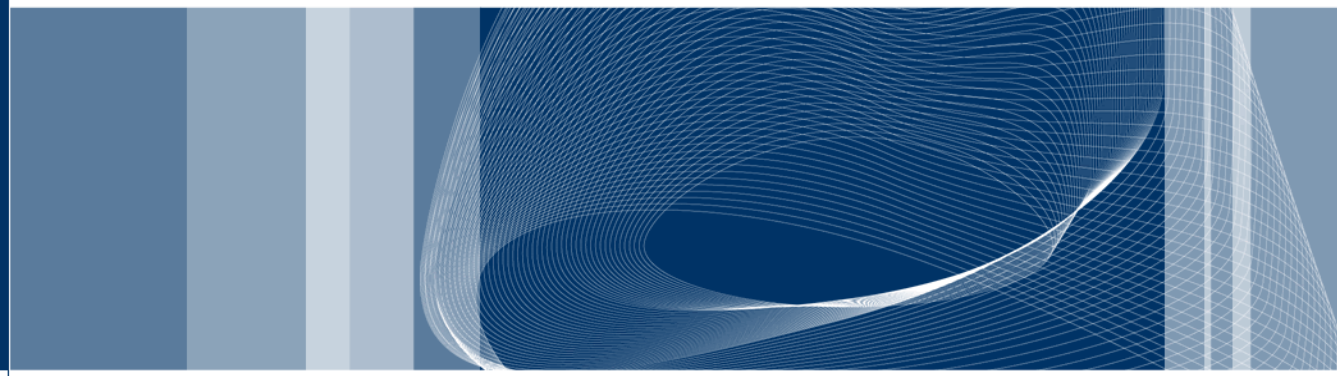
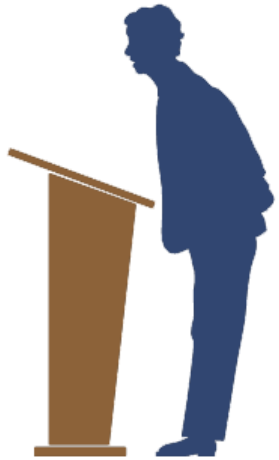


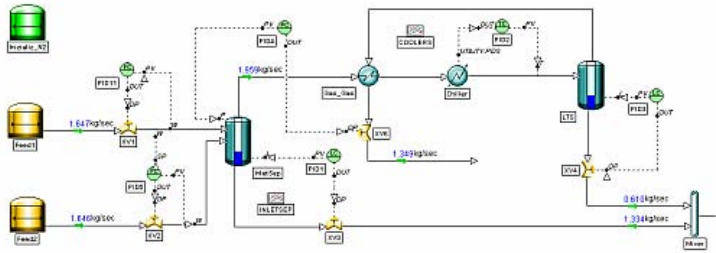
Challenges in industrial dynamics: coupling process simulation with accident simulation

Sara Brambilla and Davide Manca
Dipartimento di Chimica Materiali e Ingegneria Chimica
Politecnico di Milano – ITALY

Presentation outline

- **Dynamic Process Simulator** features
- **Accident Simulator** features
- A step forward: **coupling two worlds**
- **Example** of accidental scenario
- Simulation **results**
- Discussion
- Conclusions





Dynamic Process Simulator features

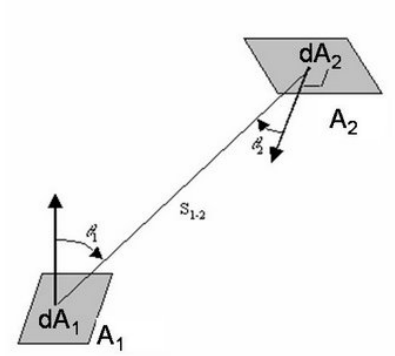
Dynamic process simulators allow:

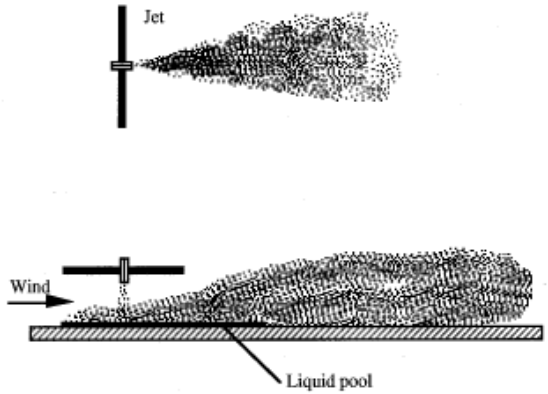
- **checking control system configurations** before implementing them on the real plant so as to uncover possible control system errors;
- **training the operators** to increase their awareness and skill;
- planning and testing the **start-up** and **shutdown** procedures;
- increasing **process safety** by testing and validating the operative procedures in a non-destructive environment.

Accident Simulator attributes

The **Accident Simulator** allows simulating the:

- **emission** of liquid/gas substances;
- **pool spreading** and **shrinking** over **soil** and **water**;
- pool **boiling** (cryogens) and liquid **evaporation**;
- **pool fire**;
- **view factors** of surrounding process units;
- **radiative heat flux** to process units and field operators;
- **gas dispersion** in complex environments;
- ...

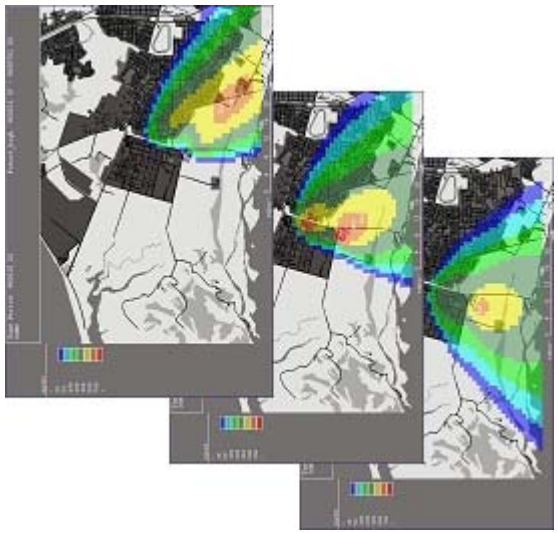


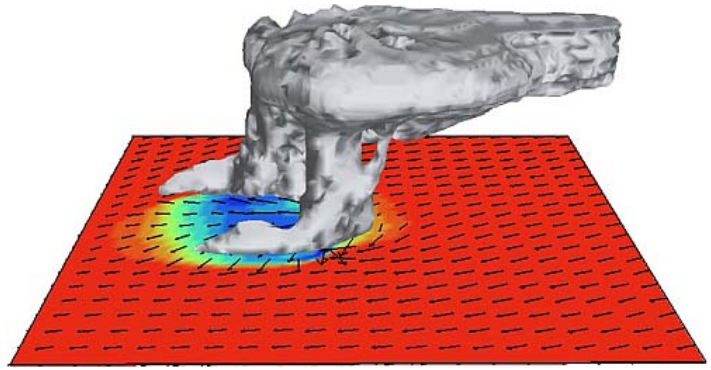


Accident Simulator features

The **Accident Simulator** allows:

- improving the **training of operators** to increase their awareness and skills;
- performing an **accident investigation** to learn from accident;
- **assessing** and **managing** the **safety**, to reduce the probability of accidents and the magnitude of their consequences;
- evaluating the **effectiveness of mitigation systems**.





Coupling two worlds...

- The previous remarks are consolidated knowledge.
- However, at present, dynamic process simulators and accident simulators are two different, independent worlds.
- **We coupled them to produce a software tool that is more than sum the of their strong points.**

The coupling

Dynamic Process Simulator

$\dot{m}_L(t_n), \dot{m}_V(t_n), T(t_n)$

$Q_{irr}(t_n), \varepsilon_i(t_n)$

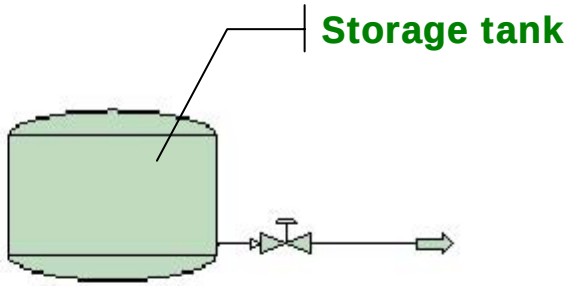
Accident Simulator

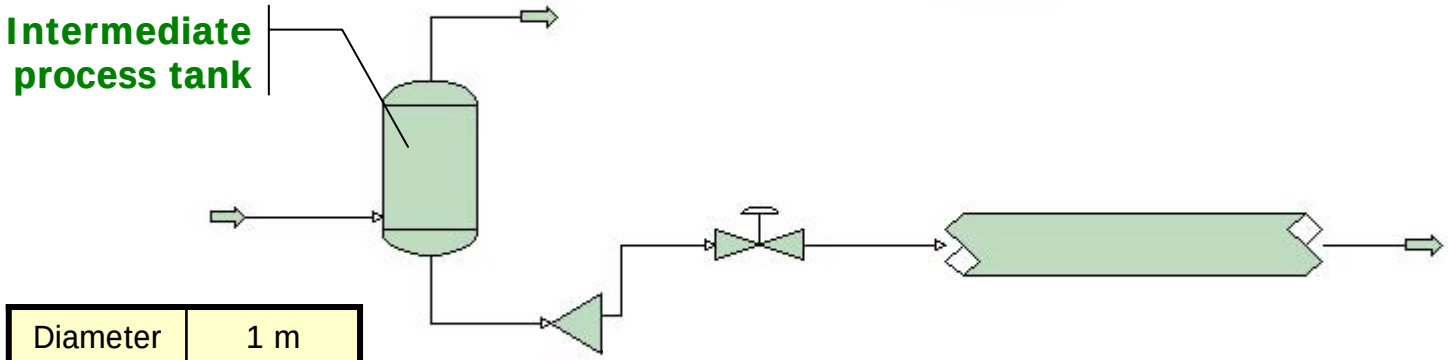
DYNAMIC SIMULATION

The Accident Simulator is either a standalone program or a user-added module of the process dynamic simulator

Accidental scenario

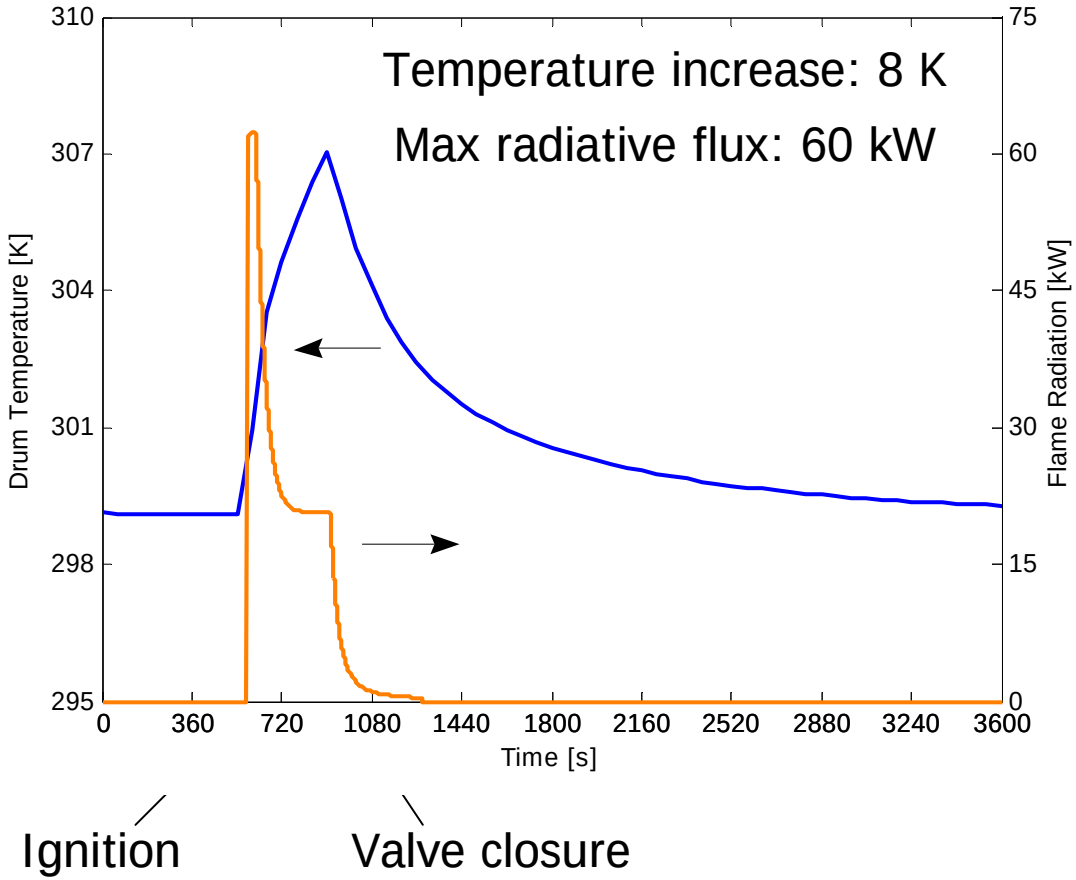
Diameter	6 m
Height	5 m
Liq. level	3 m
Holdup	**84.8 m³**



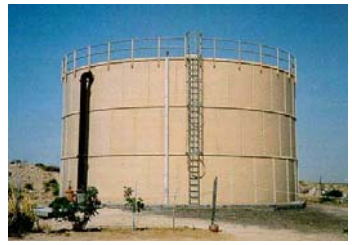


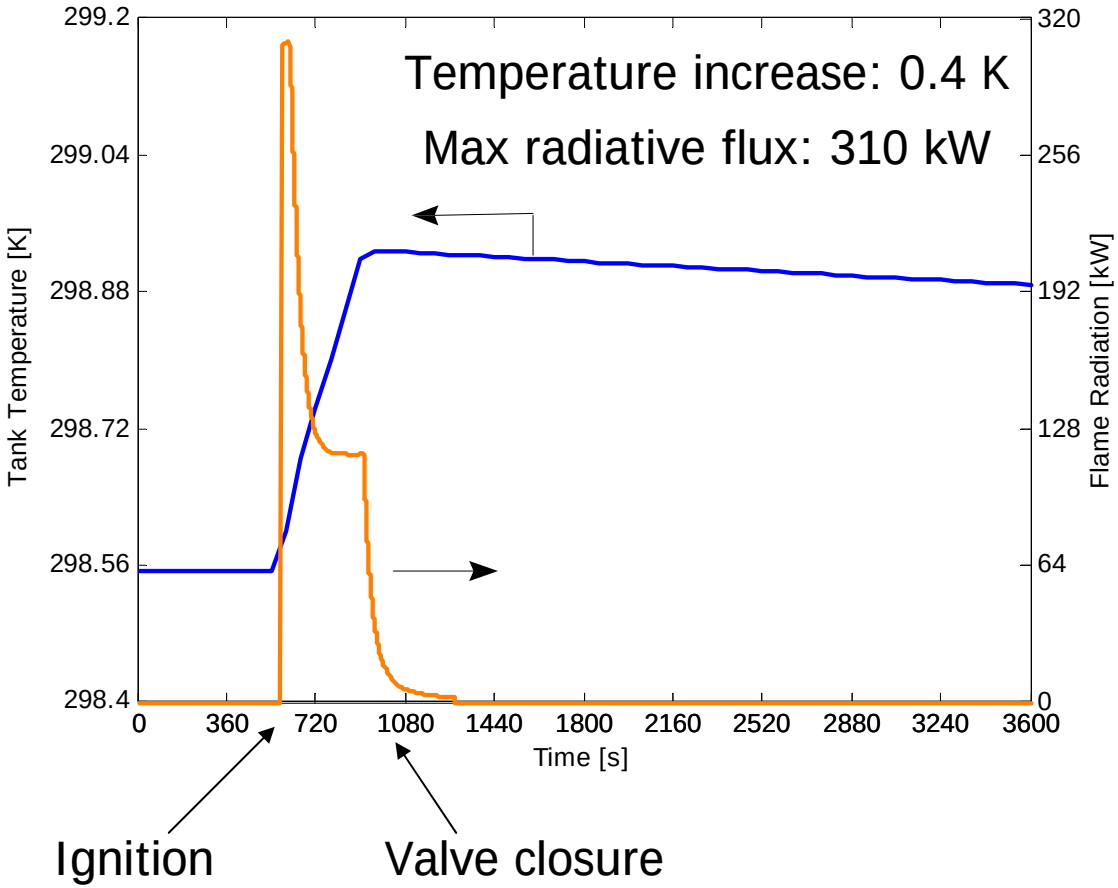
Diameter	1 m
Height	2 m
Liq. level	0-5 m
Holdup	**0.4 m³**

Intermediate process drum



Storage tank





Discussion

- **Different response dynamics** to the same accidental event in terms of both **offset** and **characteristic time**
- When the flame extinguishes, the temperature of the process drum goes back quicker to the steady-state value because of the lower material inertia and of the continuous operation

Conclusions

- This presentation showed:
  - the **link** of an accident simulator and a dynamic process simulator;
  - the **quantification** of the **interactions**;
  - the **effectiveness** of the approach in:
    - checking the **control system configurations** in case of unexpected events;
    - improving the **operator's training** and **awareness**.