Dead-legs in food process plants

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FORCE TECHNOLOGY

Presenter

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Specialist hygienic design, EHEDG AEO

More than 25 years experience with hygienic design and food production

Leader of hygienic test facility, focus on industrial hygienic design, test of cleanability

CV

- 1998 – 2011 principal scientist in research projects (DK, Nordic and EU)
- Author of a series of papers and book chapters on hygienic design and CFD for optimized cleaning
- EHEDG Working groups: Training and Education, Hygienic Integration and Open Processes
- EHEDG Authorized Evaluation Officer and Trainer
- Technical University of Denmark, Tech4Bizz (own company) and now FORCE

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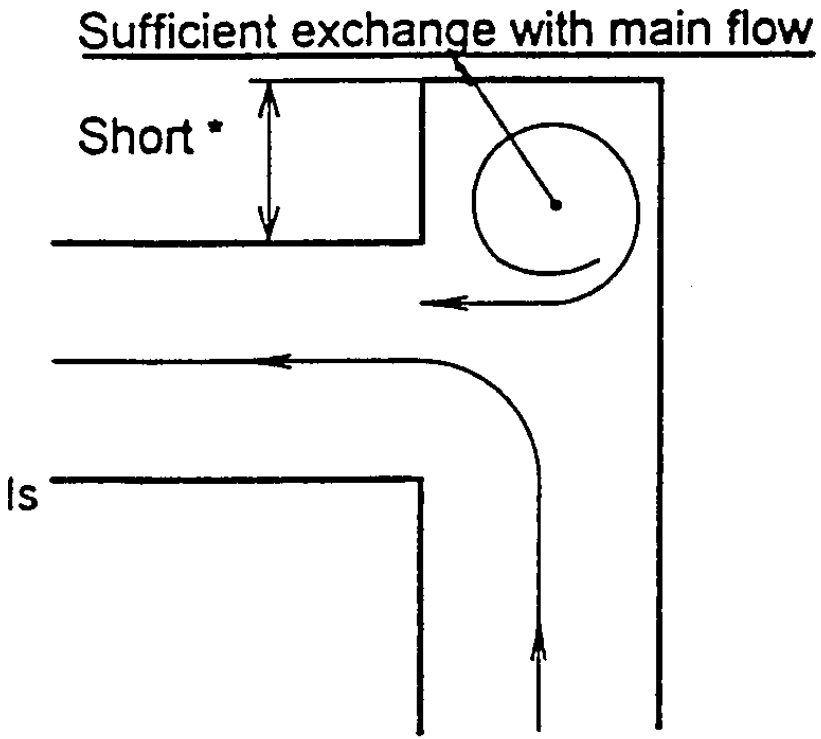
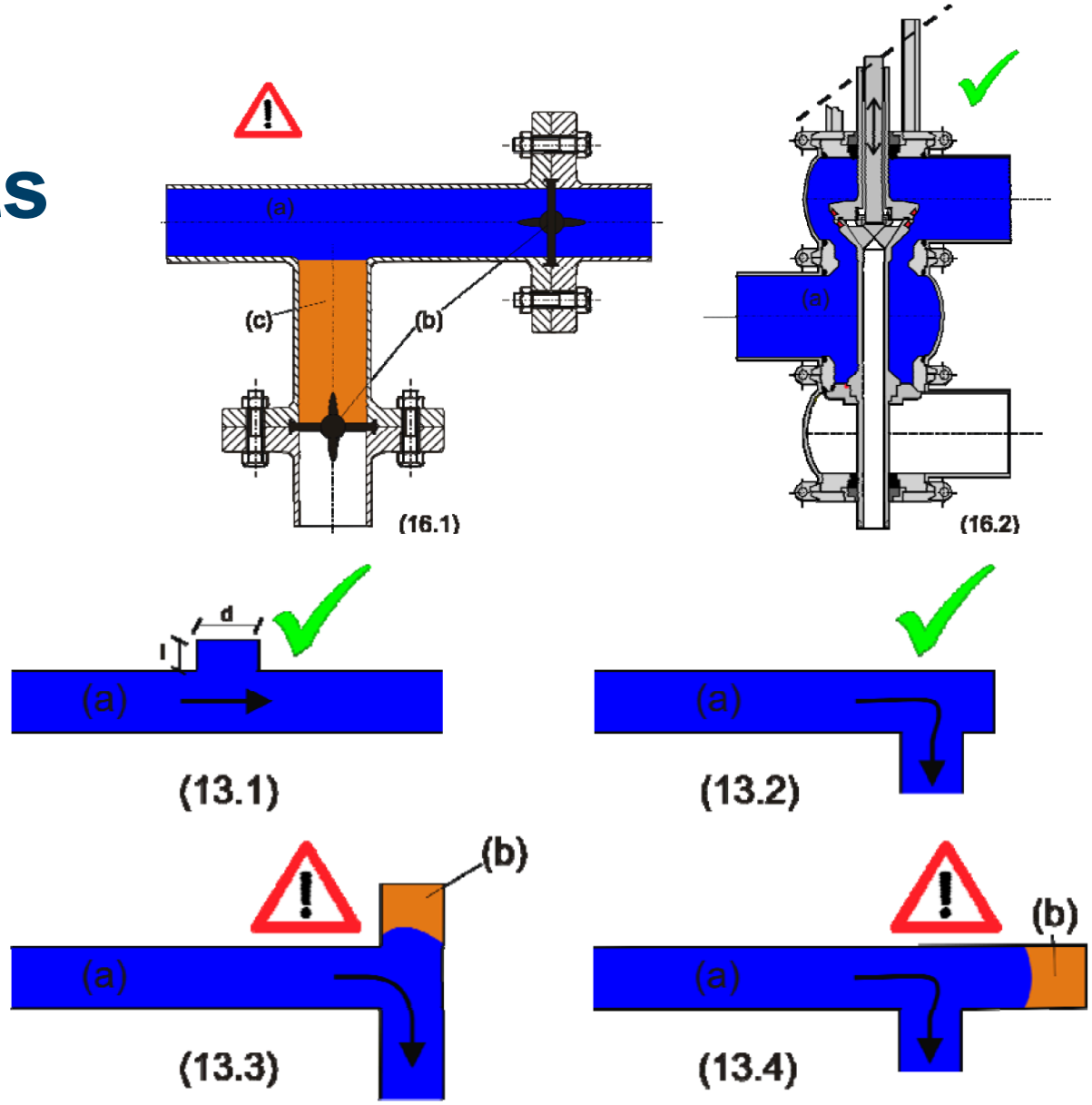
Closed process equipment

Dead-legs can not be avoided in process plants



ONLY ACCEPTABLE IF UNAVOIDABLE



EN 1672-2

EHEDG Guideline no 10

Criteria for 'permissible' dead-legs

- Criteria are based on the ratio of the **diameter of the pipe (D)** to the **depth of the dead-leg (L)**, where L is usually measured from the pipe wall
- In general, the acceptable depth is specified at a depth relative to the diameter ratio expressed by $\mathbf{L \leq x \cdot D}$
  - The value of 'x' depends on the reference
- There are different rules which, under different conditions, specify:
  - 1D; 1.5D; 2D; 3D or 6D.
- Which one is the right one to choose then?
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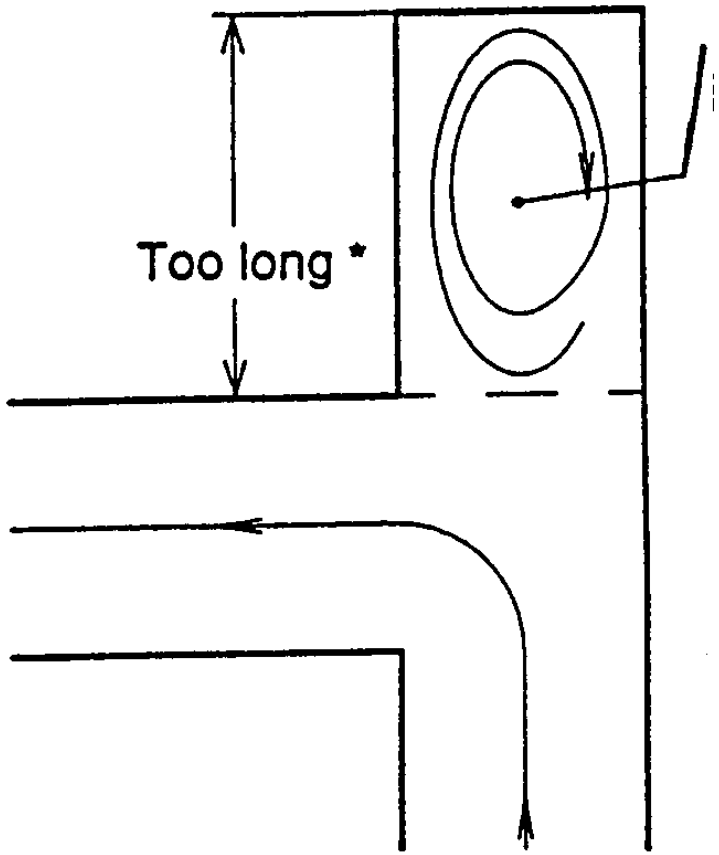
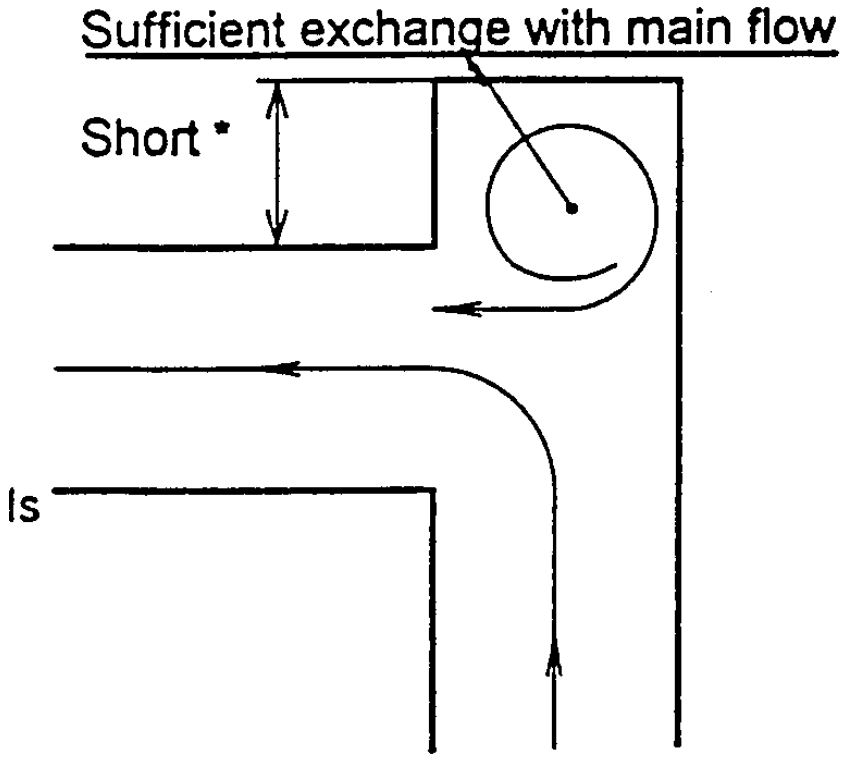
Dead-legs



Dead space – insufficient exchange with main flow

EN 1672-2



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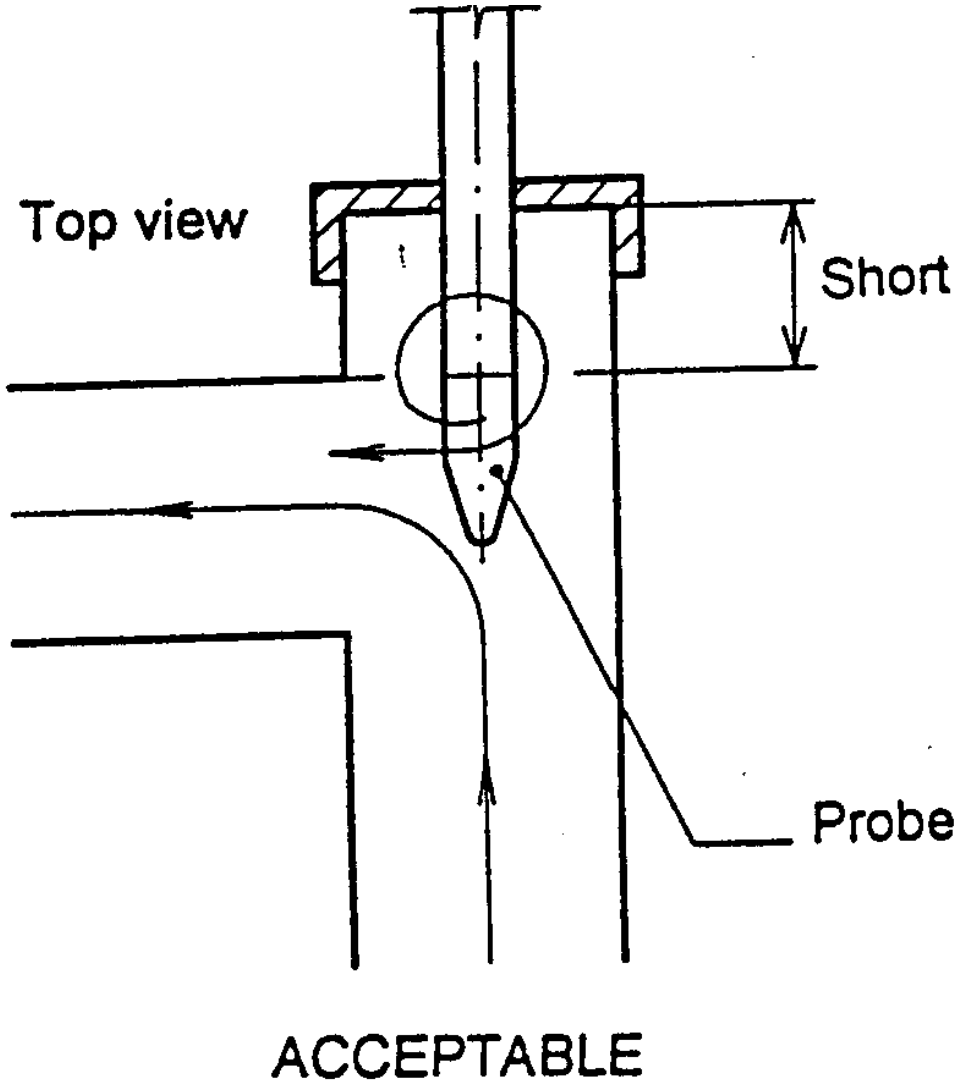
Acceptable length of a dead-leg mainly depends on viscosity and flow velocity

Dead-leg wit sensor

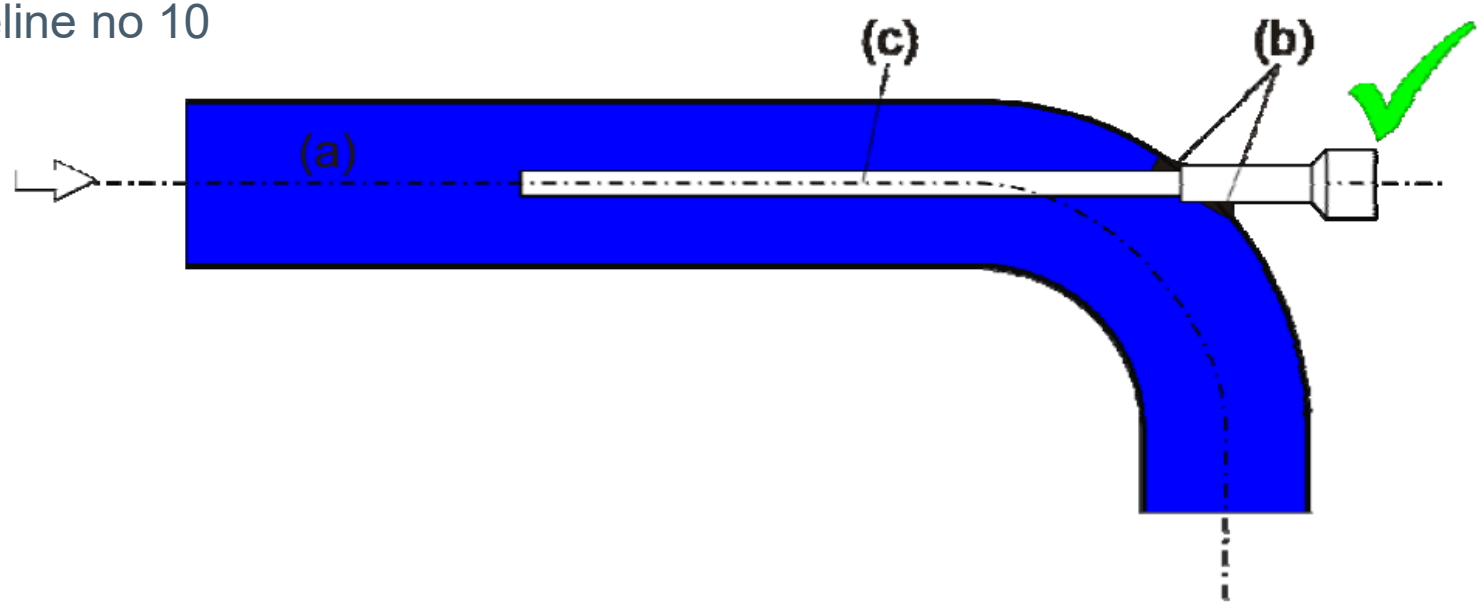
EN 1672-2

The sensor breaks flow pattern



Sensible sensor placement

EHEDG Guideline no 10



(a) product area, (b) weld, (c) temperature sensor

Europe, the food industry including EHEDG

- The European dead-leg criteria are the toughest
- The harmonized standard EN1672-2 prescribes:
  - that dead-legs should preferably be avoided
  - if they cannot be, they must be as short as possible
- The requirement of the European Hygienic Engineering and Design Group (EHEDG) is
  - the depth of dead-legs must be less than or equal to the diameter of the pipe

US, biotech & pharma inklusiv FDA, 3-A, ASME-BPE, ISPE & WHO

- The pharmaceutical industry standard seems to be a 3D rule
  - This is supported by ISPE, which has the 3D rule in their guidelines for water production systems for pharmaceutical use
- 3-A Sanitary Standards Inc and ASME BPE-2019 (American Society of Mechanical Engineers for Bioprocessing Equipment) applies a 2D rule
- The biotechnology industry sometimes applies a 1.5D rule without it being documented in standards or guidelines
- The FDA also has a 6D rule that measures the length of the dead-leg from the pipe center line. This is still used by the FDA as a guide to GMP inspections

Criteria for length of dead-legs

EHEDG (food products)

- The depth must be less than the pipe diameter L ≤ 1D

3-A & ASME BPE (all products)

- The depth must be less than 2 * pipe diameter L ≤ 2D

Pharma industry (sterile water plant)

- The depth must be less than 3 * pipe diameter L ≤ 3D

In food processing facilities, it is not recommended to make longer death ends than EHEDG's criteria

Warning! When death ends exceed EHEDG's requirements, this should be combined with longer cleaning time or with steam sterilization of plants

In all criteria, the length of the pipe wall is measured

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Importance of liquid flow

- Mechanical force - shear rate
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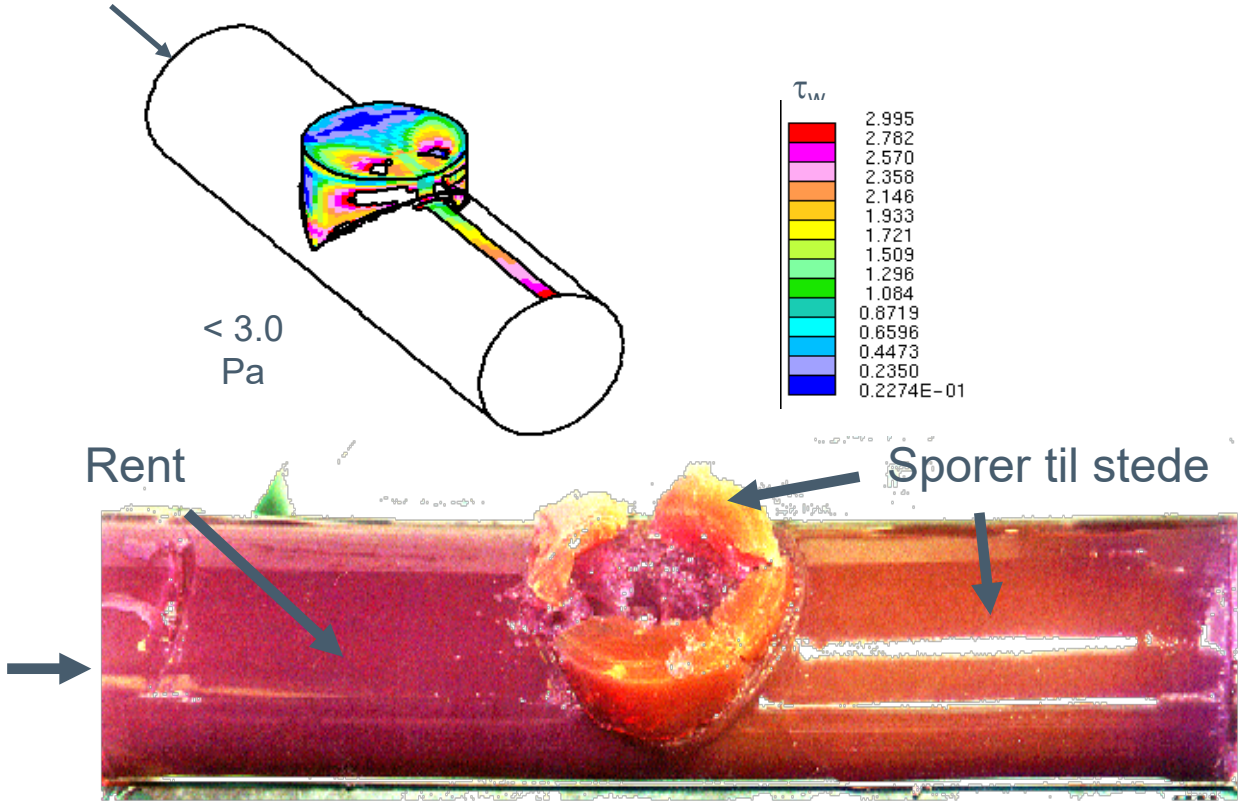
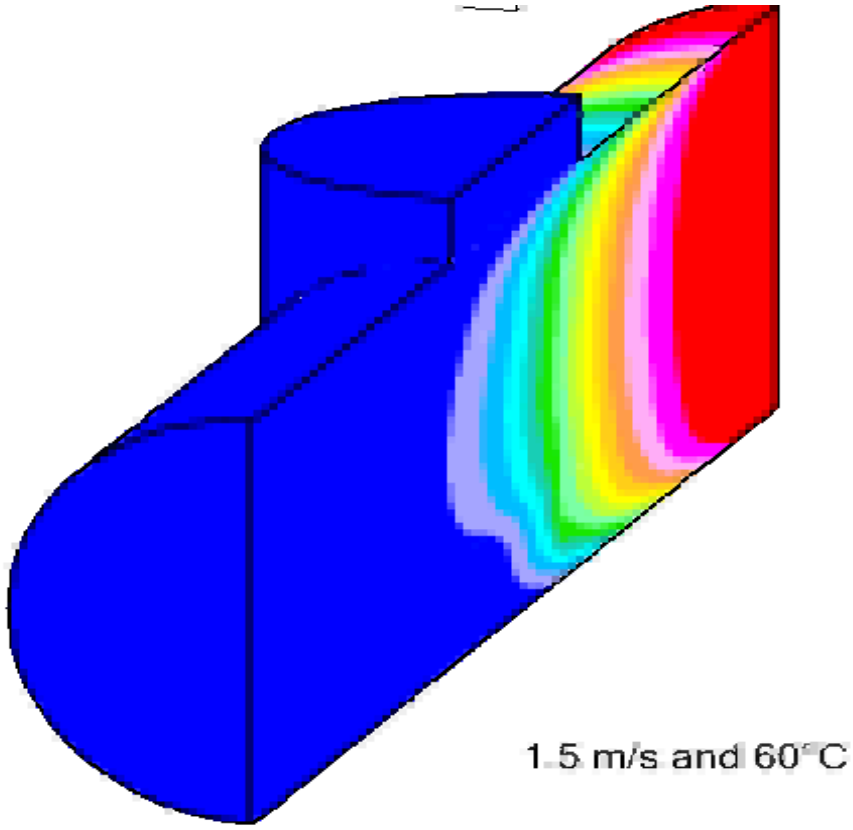
v_0 ⟶ $v_1 = 1/8\ v_0$ og $v_2 = 1/8\ v_1 = 1/64\ v_0$

!!! Very low shear force in dead-leg

Upstand geometry – L/D = 0.2



Source: Campden & Chorleywood Food Research Association Group



Thank you for your attendance

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Questions are welcome

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