University of Žilina
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IMPROVING CUTTING CAPABILITY OF PLASMA BEAM BY MODIFYING NOZZLE GEOMETRY SUPPLIED BY FEM

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Aims of the presentation

- Plasma cutting
- Design of plasma torch
- Modifications of nozzle geometry
- FEM analysis
- Analyse of experimental cuts
- Conclusion

Plasma cutting

- Cutting gas: air
- Power source: Cebora 3600
- Current range: 20 - 100A
- Cutting capability: max. 30 mm
- Manual control mode
- CNC mode

Design of plasma torch

- Reference nozzle diameter – ø 1,4 mm
- For simulation 2D model

1 – shield

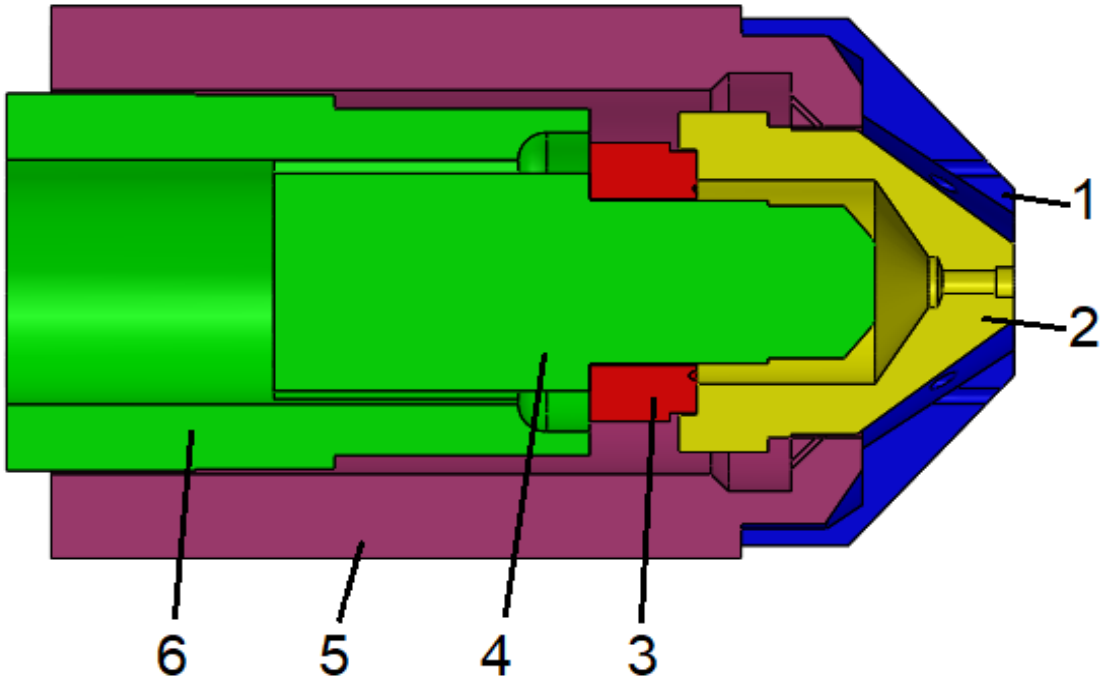
2 – reference nozzle

3 – swirl ring

4 – electrode

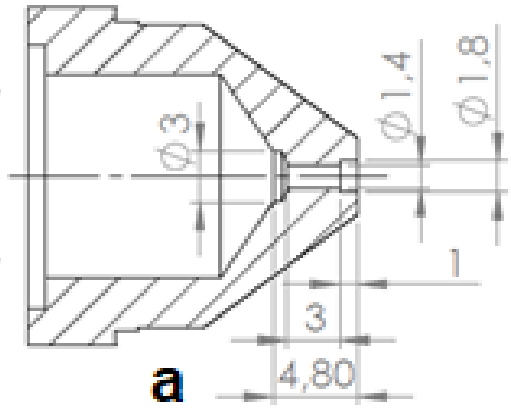
5 – retaining cap,

6 – torch body

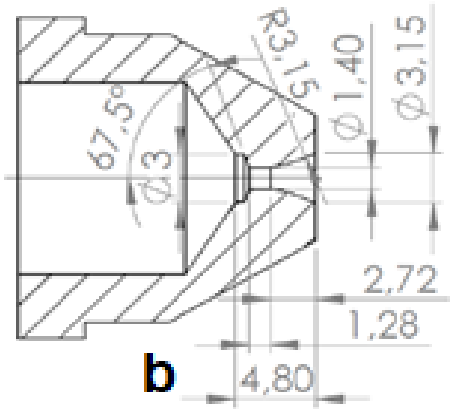


Modifications of nozzle geometry

- de Laval nozzle
- Requirements for modifications:
  - Conventional technology for the manufacturing
  - Short production time
  - Low cost production
- 8 modified shape



a) Reference nozzle

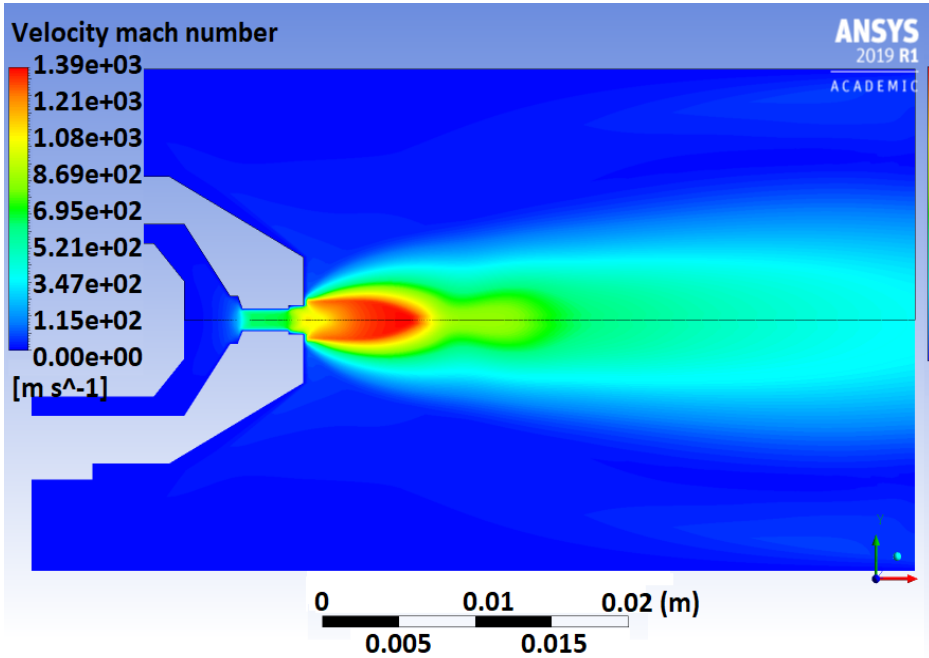


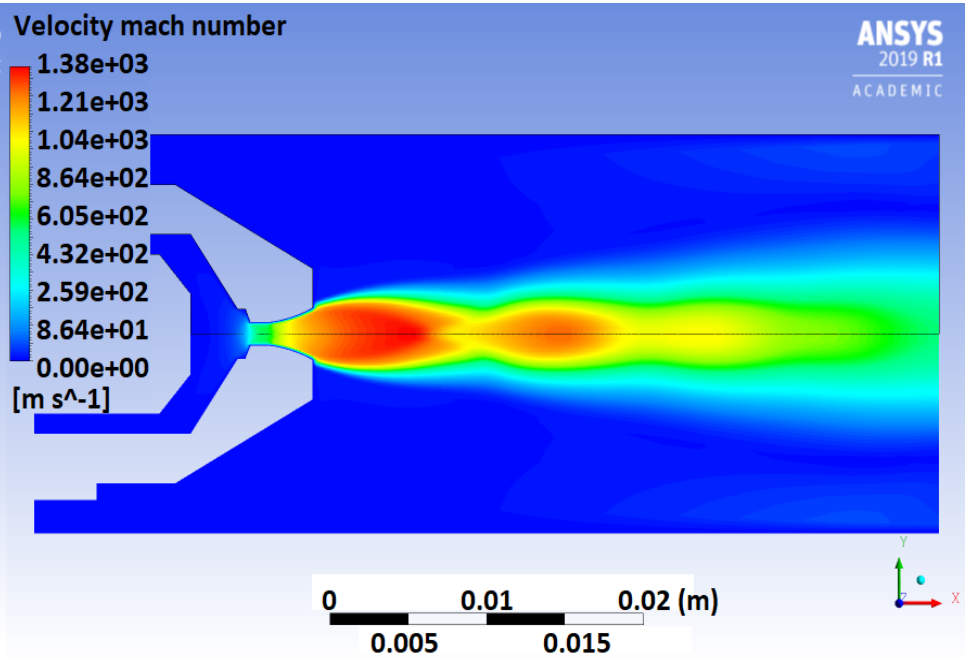
b) Modified shape

FEM analysis

- 2D model
- Inlet pressure 2,26 MPa, temperature 1200 K
- Outlet pressure 39,4 kPa, temperature 273,2 K
- Ideal gas
- 1 – inlet, 2 wall, 3 – axis of symetry, 4 - outlet

Flow simulation





Reference nozzle

one core

cylindrical shape of flow

Modified nozzle

second and third core

sligtly diverging shape

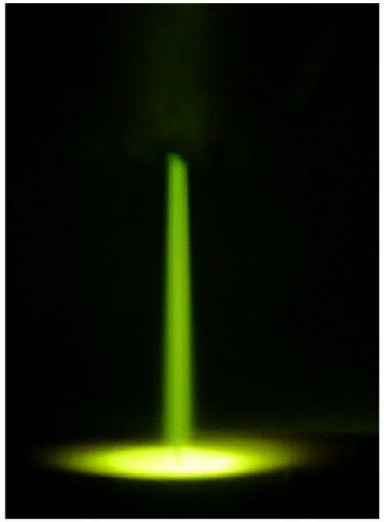
Experimental cuts

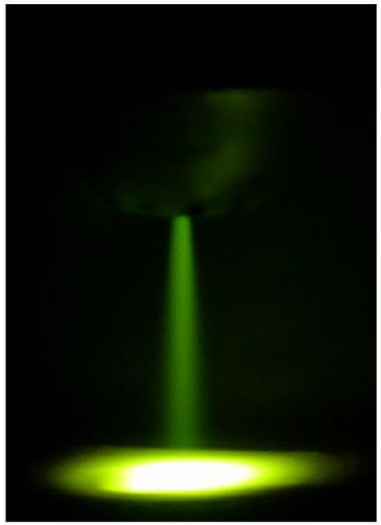
- Cutting parameters:
  - Current: 70A
  - Cutting speed: 610 mm/min
  - Gas pressure: 0,3 MPa

- CNC controled torch
- Plasma gas - air

Pilot plasma beam

Cutting plasma beam



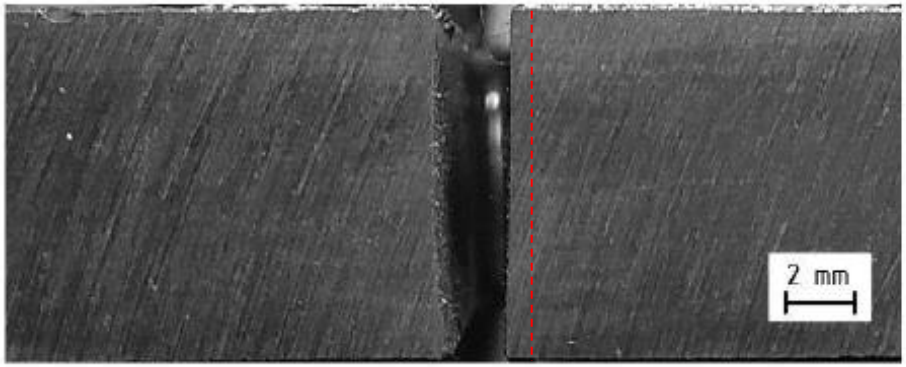


Left side is reference nozzle and right side is modified nozzle

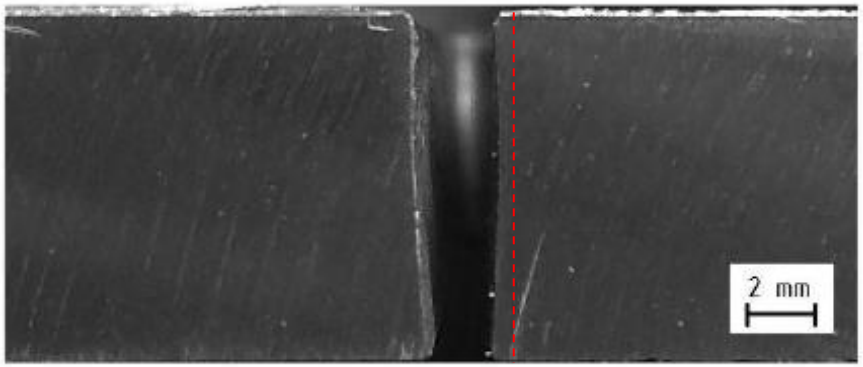
Experimental cuts

- Experimental material: S235 steel with 10 mm thicknes
- Wider cutting gap
- Bigger deviation from the perpendicular

Macrostructure of cutting gap



Reference nozzle



Modified nozzle

Conclusion

- Requirements for manufacturing were fulfil
- Simulation of reference nozzle correspond to the pilot arc
- Simulation of modified nozzle do not correspond to the real plasma beam

- Proposals for next research:
  - Used 3D model
  - Considering effect of swirl ring
  - Use modified nozzle for further research into cutting thin metal sheets

Thank you for your attention