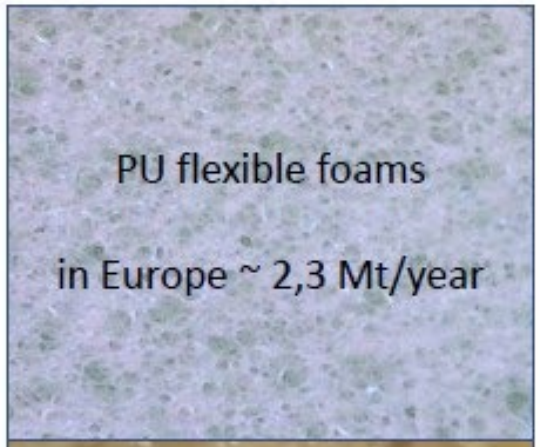
INNOVATIVE SHAPED THERMAL INSULATION ELEMENTS MADE FROM RECYCLED POLYURETHANE FOAM

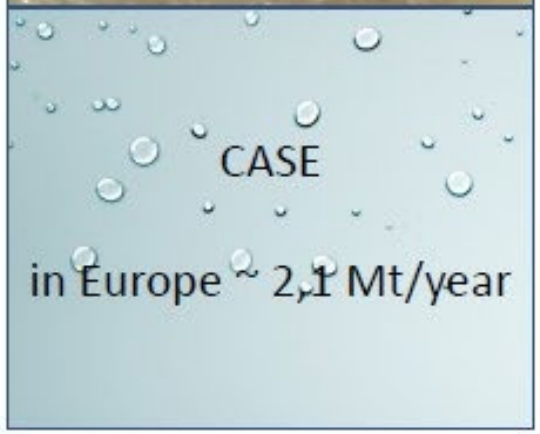
Miloš Matúš

PUR foam production

The amount of waste **PUR foams from the processing of old vehicles** in the Slovak Republic is relatively stable and this value varies on average around **450 tons per year** (≈12 000 m^3).

The market attained a volume of **15.5 million tonnes in 2022**, experiencing a growth of **8.3%** (2026-2033).





Furniture and Interiors

Construction

Electronics ans Appliances

Automotive

Footwear

Packaging

Others (ndustrial insulation, CASE and so on)

Post-production scraps

Product life

Landfil
~ 50% of waste

Incineration
~ 30% of waste

Recycling
~ 20% of waste

Material recycling

- Adhesive pressing
- Partial bonding
- Injection moulding
- Compression moulding

Chemical processing

- Hydrolysis
- Glycolysis
- Alcoholysis

Thermo-chemical processing

- Pyrolysis
- Gasification
- Hydrogenation

Energy recovery

- Municipal waste combustion
- Fluid kilns
- Rotary kilns
- Thermal degradation

Design of suitable technology

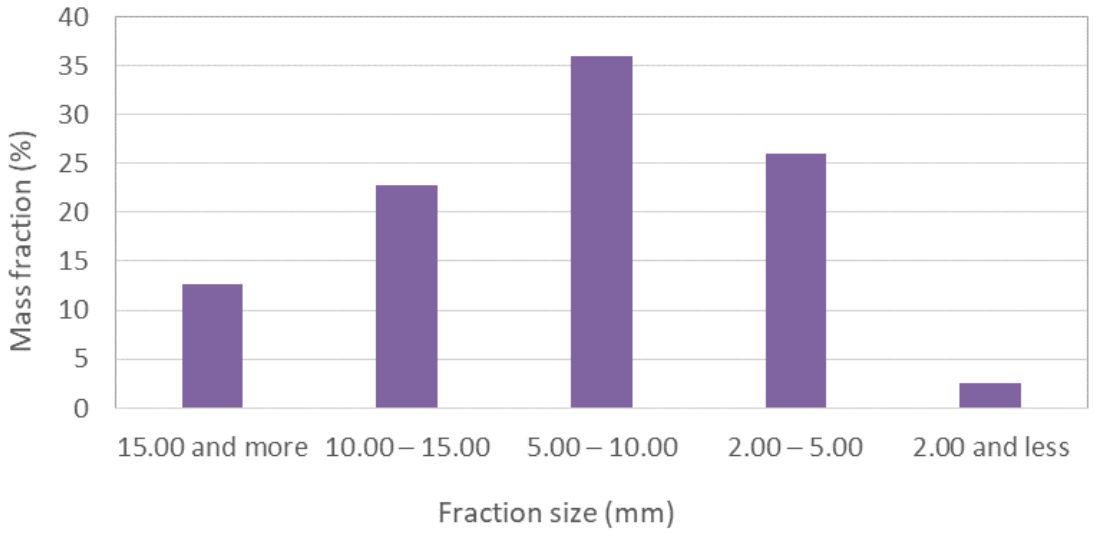
Amount and type of recycled material
Economic and technological demands
Product applicability on the market

COMPRESSION MOULDING

Basic requirements:

- recycling of pure PUR foam and PUR foam with an integral surface layer,
- production of flat and shaped insulating products without a binder,
- highly investment-efficient technology for the recycling of PUR foams from old vehicles in Slovakia,
- wide application of products due to the variability of shapes, strength, density,
- guaranteed mechanical properties of products.

Experimental development of technology



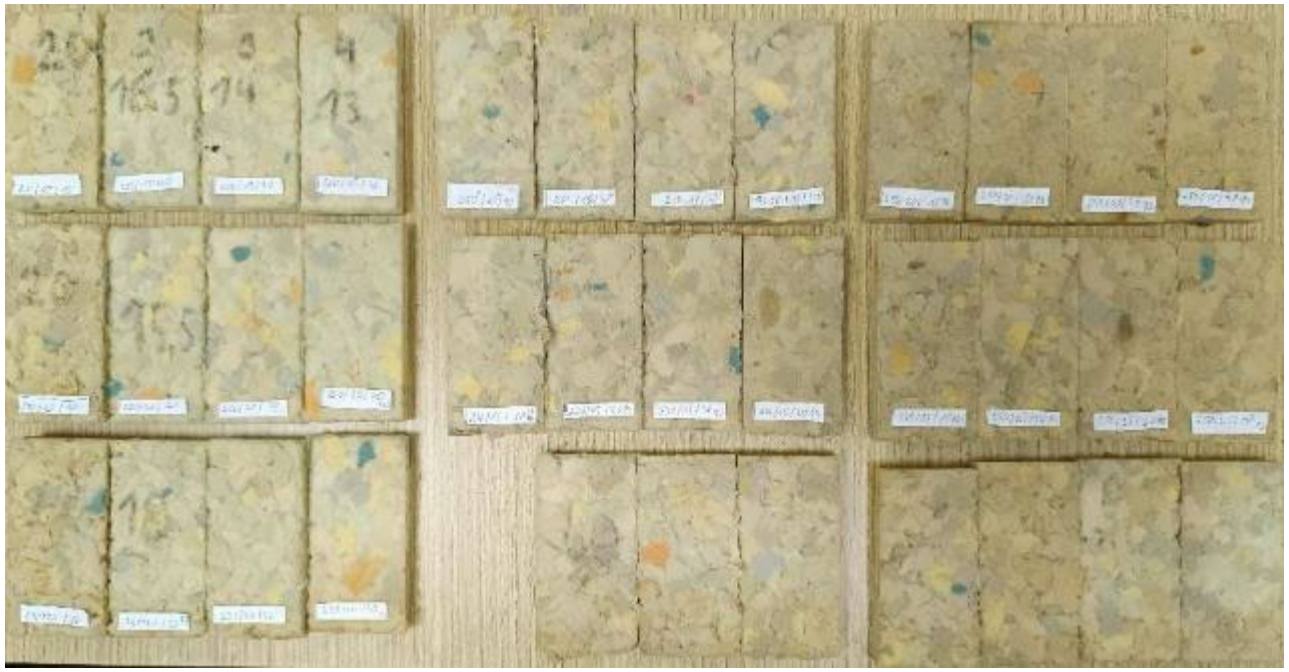
The considered variable parameters of the process are:

- **Compacting pressure (2.0 kPa, 4.0 kPa, 6.0 kPa, 8.0 kPa),**
- **Heating temperature (200°C, 225°C, 250°C),**
- **Heating time (10 min., 15 min., 20 min., 25 min., 30 min.).**

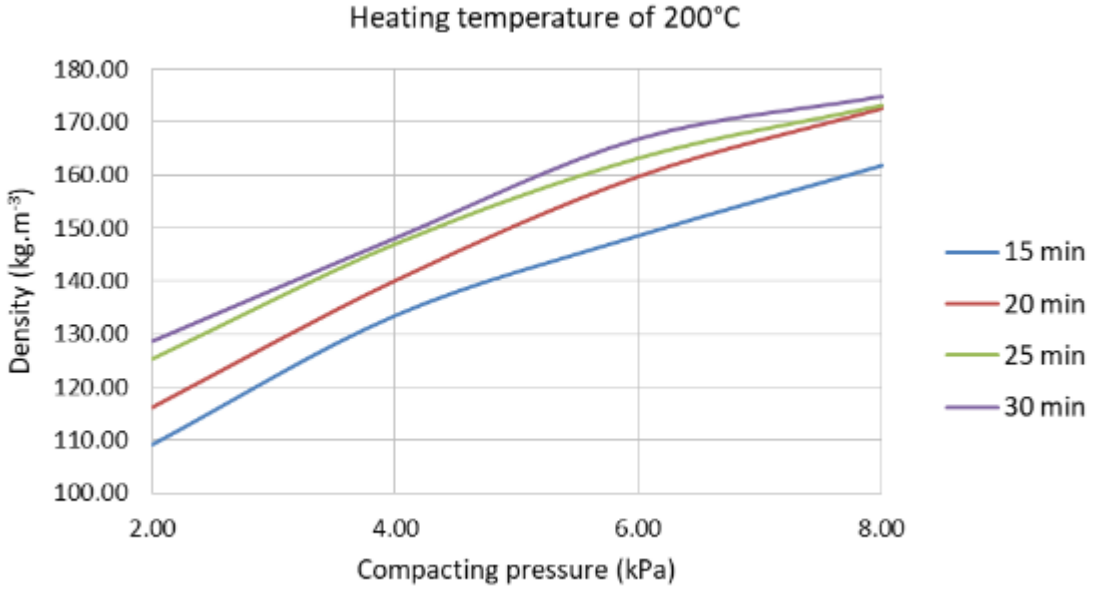
Forming procedure

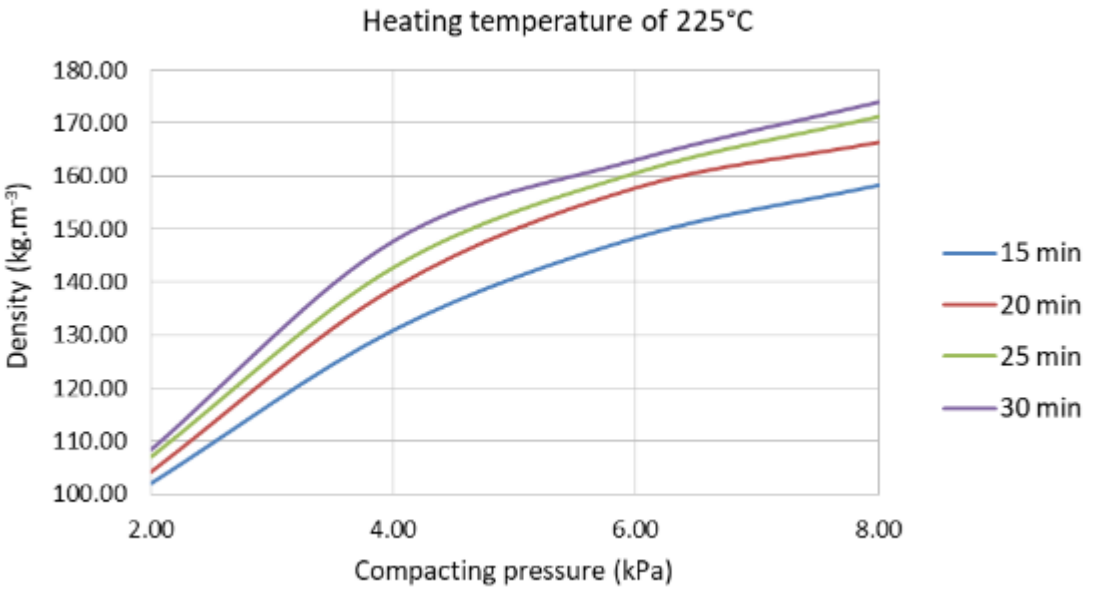
Samples characteristics

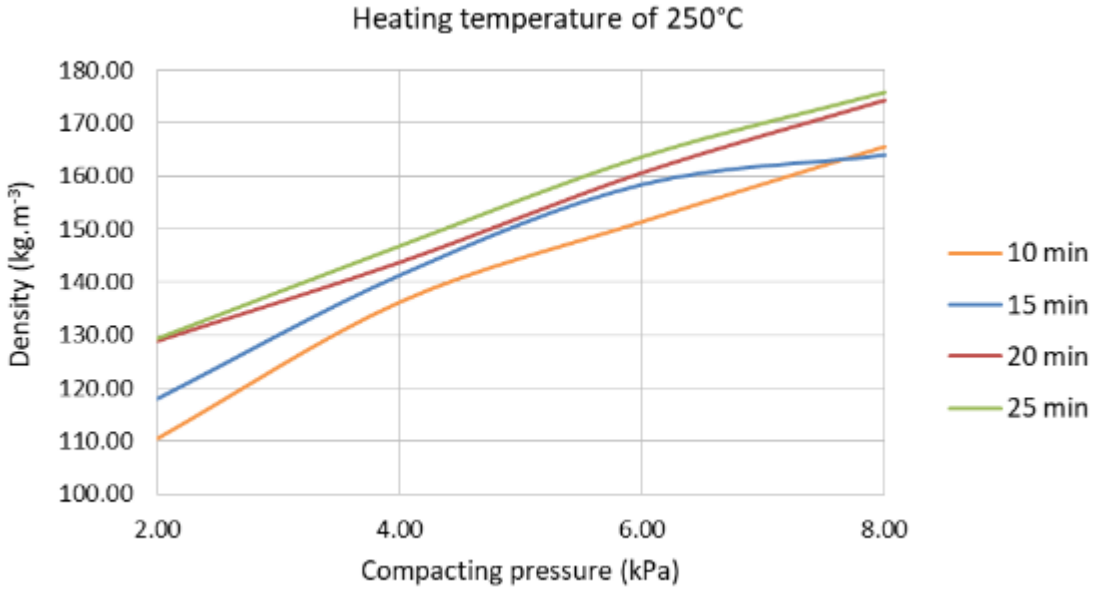
Heating temperature 200 °C					
Heating time (min)	10	15	20	25	30
Pressure (kPa)	Density (kg.m^{-3})				
2,00	Incoherent, unstable in shape	102,10	104,30	107,11	108,49
4,00		131,00	138,93	142,85	147,82
6,00		148,43	157,85	160,65	163,09
8,00		158,31	166,40	171,24	173,98
Heating temperature 225 °C					
Heating time (min)	10	15	20	25	30
Pressure (kPa)	Density (kg.m^{-3})				
2,00	Incoherent, unstable in shape	99,17	116,20	125,33	128,67
4,00		133,55	140,14	147,05	148,15
6,00		148,60	159,78	163,25	166,88
8,00		161,84	172,60	173,18	174,87
Heating temperature 250 °C					
Heating time (min)	10	15	20	25	30
Pressure (kPa)	Density (kg.m^{-3})				
2,00	110,4865	118,00	128,90	129,38	Material degradation, sintering
4,00	136,2667	141,33	143,77	146,86	
6,00	151,4286	158,46	160,67	163,68	
8,00	165,60	164,00	174,36	175,83	



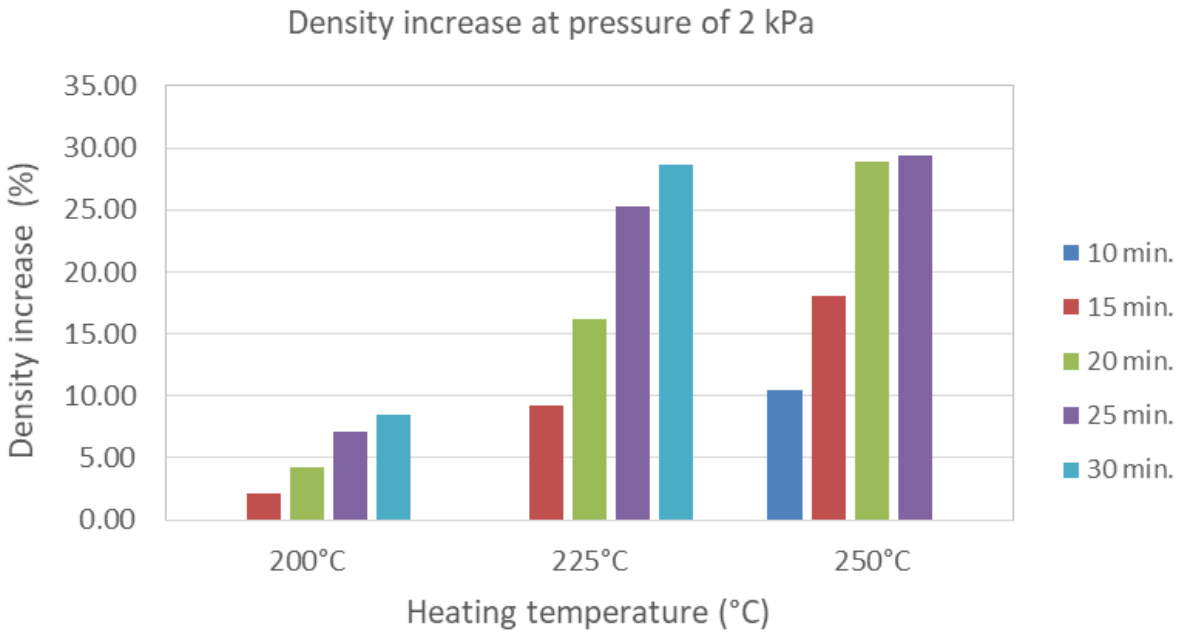
Density of recycled samples

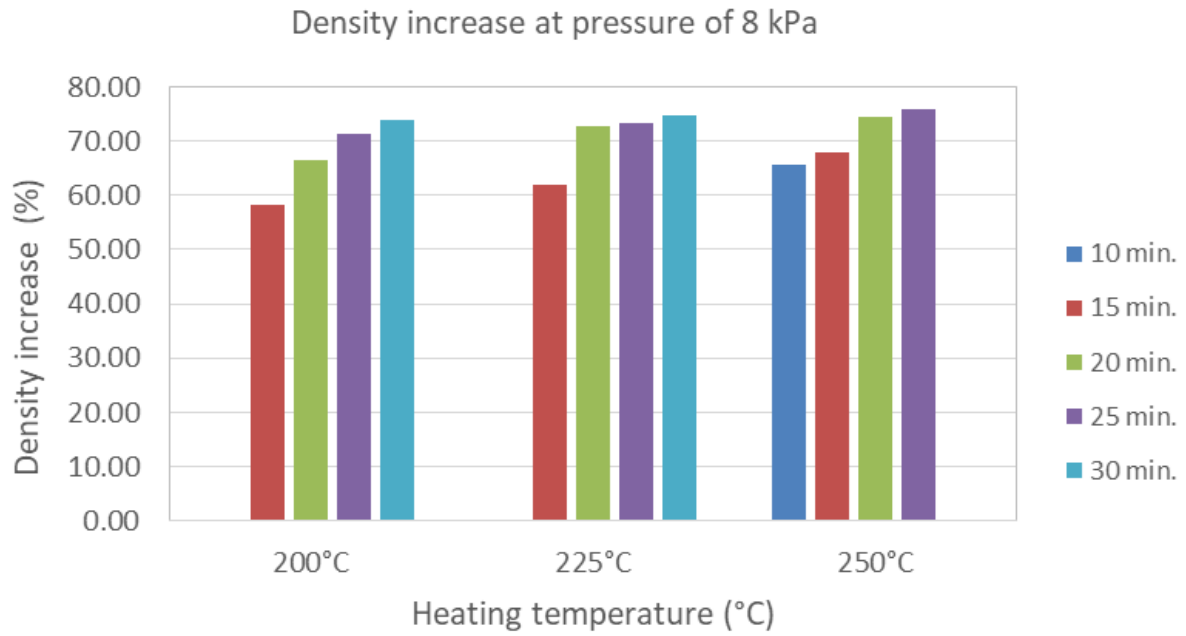






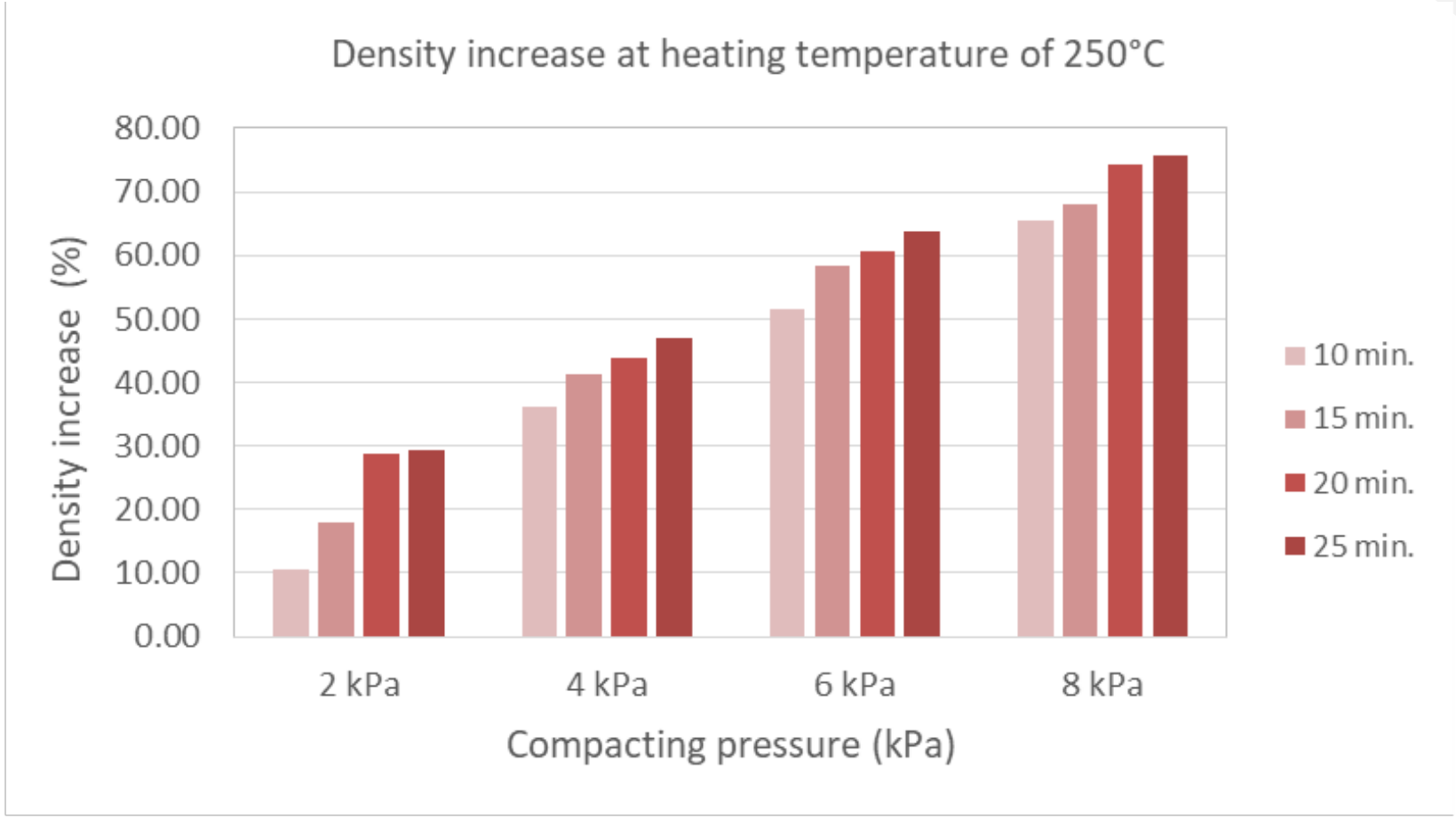
Effect of temperature and heating time on density





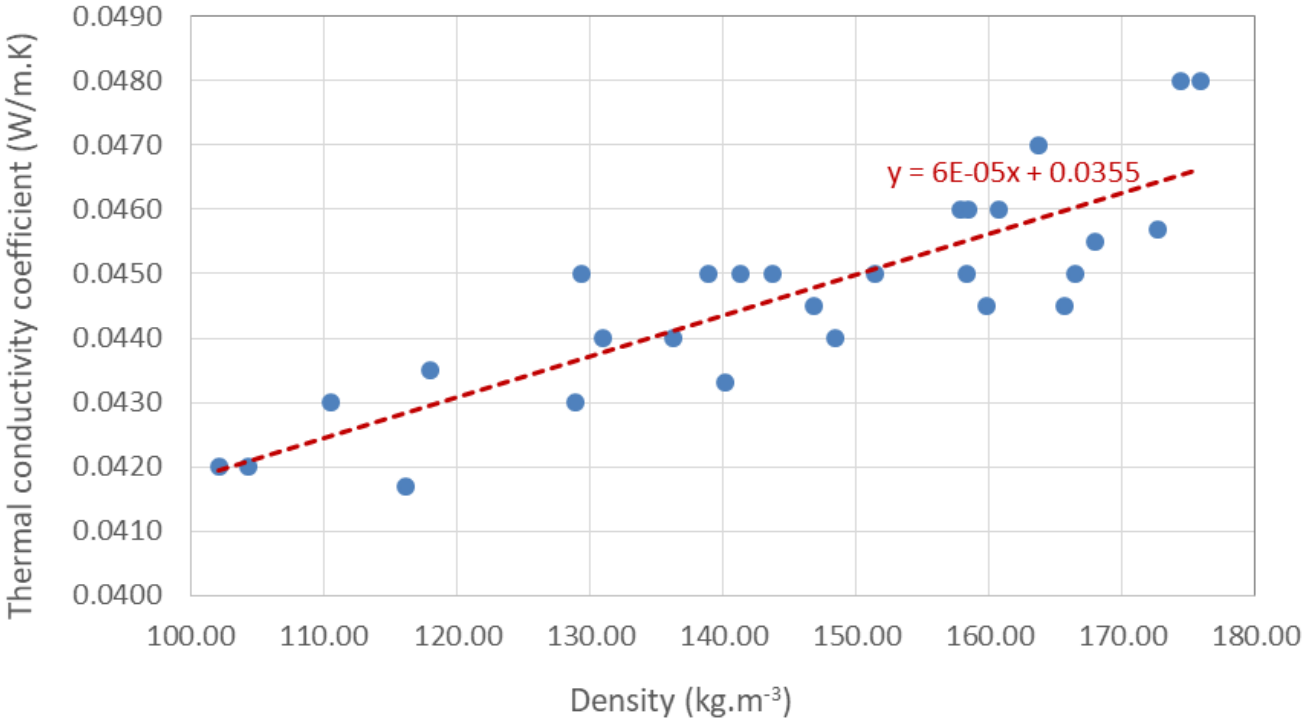
Density "0" at 20°C and 0 Pa is 100 kg.m^{-3}

Effect of compacting pressure and heating time on density



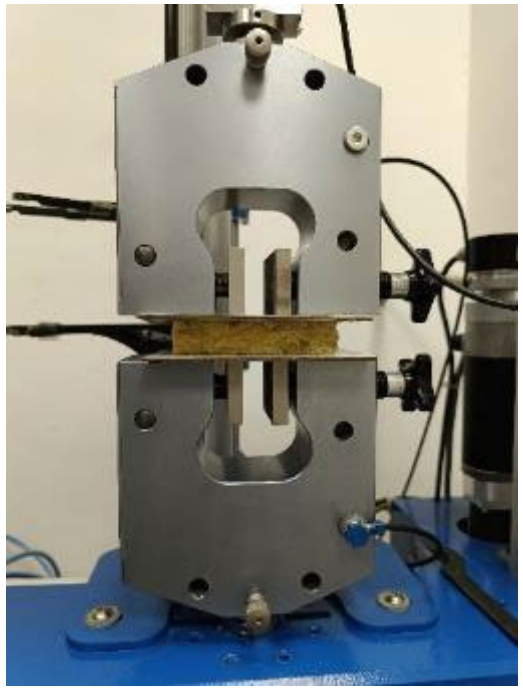
Density "0" at 20°C and 0 Pa is 100 kg.m^{-3}

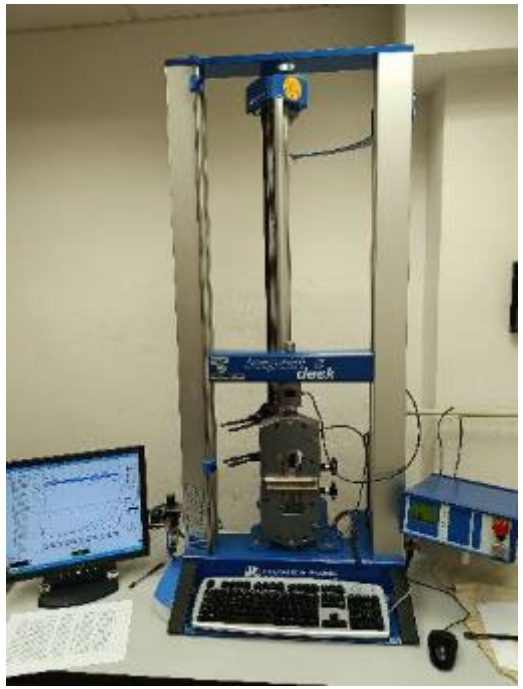
Thermal conductivity coefficient

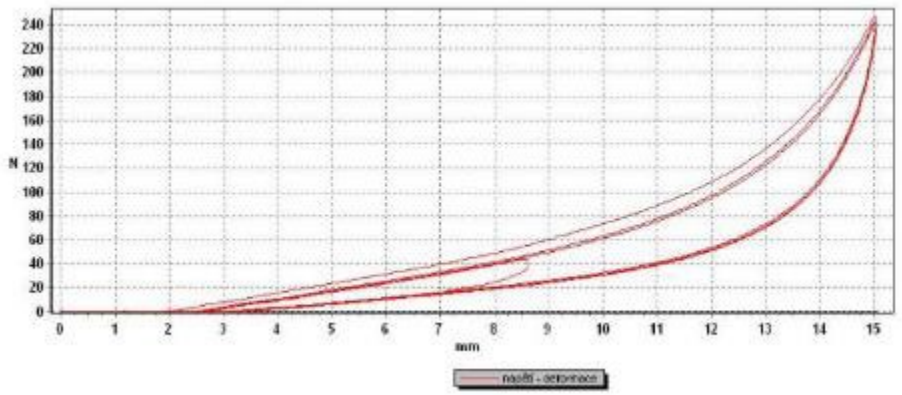


Mechanical properties optimization

Compressive strength test (ISO 3386-1)







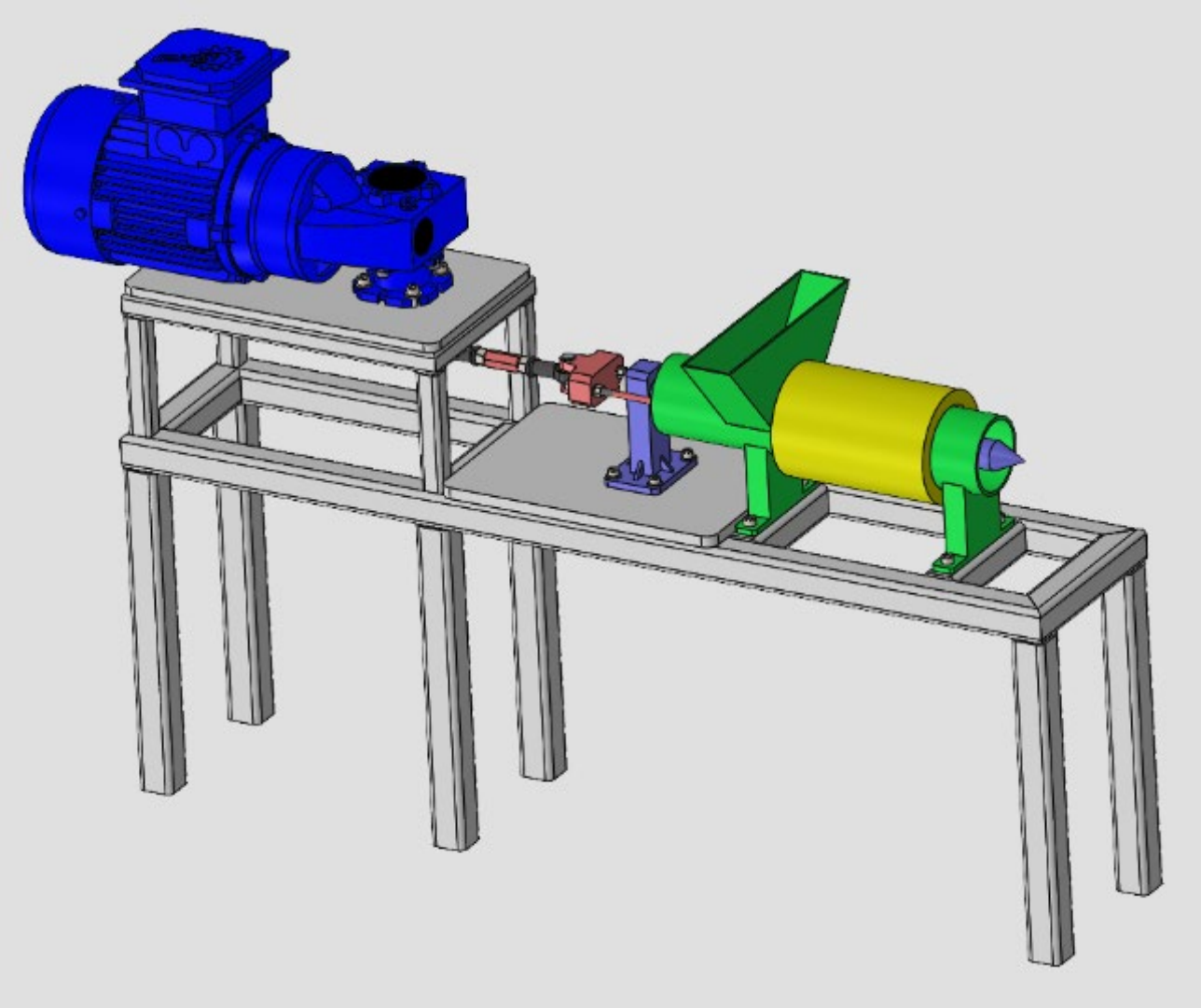
Tensile strength test

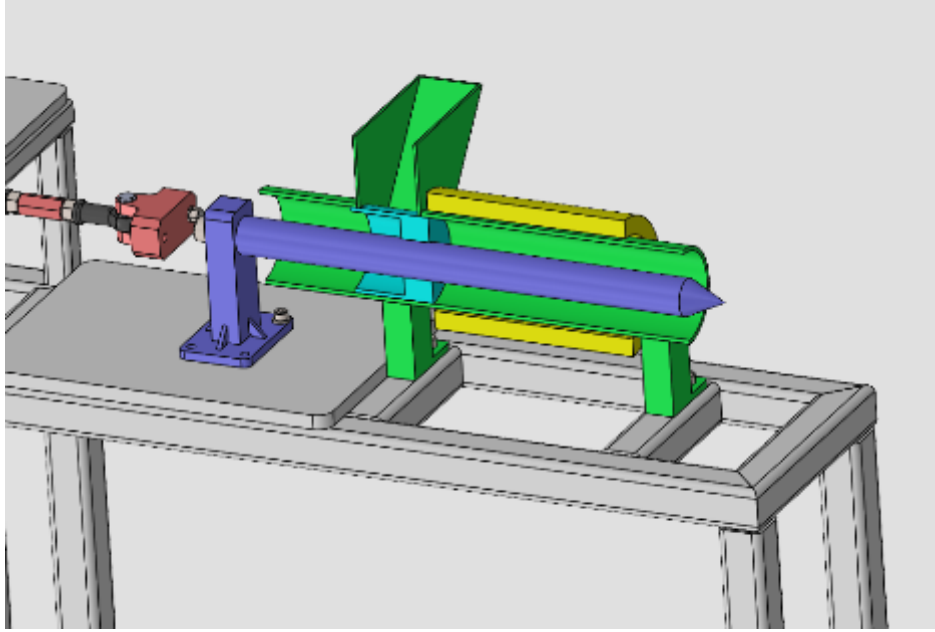
Shaped thermal insulation parts

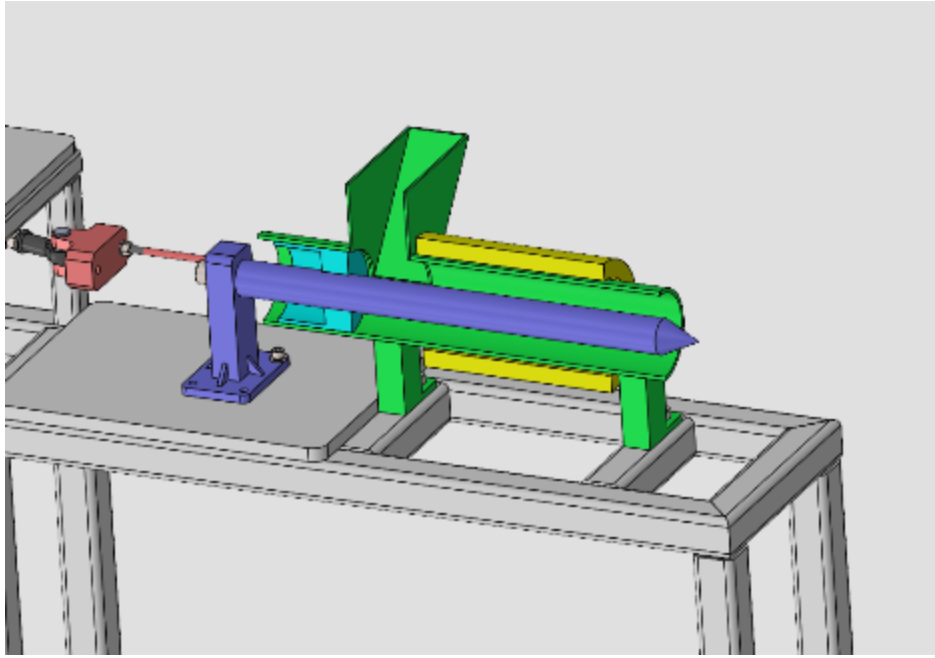
Coating of thermal insulation parts

- without coating
- plastic (PE, LDPE, PVC, etc.)
- aluminium

Continuous production technology for cylindrical thermal insulation







Conclusion

- Developed and proven effective compression molding of PUR recycled material without glue
- Optimization of technological production parameters
- Development and verification of shaped thermal insulation parts
- Testing of thermal insulation properties of parts
- Development of coating
- Development of production technology for shaped parts

Thank you for your attention

Miloš Matúš

+421 905 256 462

milos.matus@stuba.sk

www.sjf.stuba.sk