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DENSITY-PRESSURE RELATIONSHIP IN DENSIFICATION OF SWINE SOLID FRACTION

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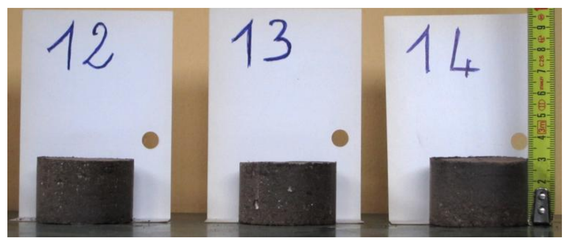
Introduction

In accordance to European Regulation (91/676/CEE), which limits the amount of nitrogen available for distribution on agricultural lands that are in nitrate vulnerable zones (NVZ), livestock farms have to find alternative solutions for manure management. In order to avoid water pollution several technologies have been developed and one of these is solid-liquid separation. It allows to obtain a solid fraction and a clarified liquid.

As a consequence of low bulk density, the solid fraction is very difficult to handle, transport and store. One solution to these problem is densification into pellets, briquettes or cubes (Kalian and Vance Morey, 2009).
Densification increases the bulk density of biomass from 40-200 kg·m^{-3} to 800 kg·m^{-3} and more (Mani *et al.*, 2003; Obernberger and Thek, 2004; McMullen *et al.*, 2005).

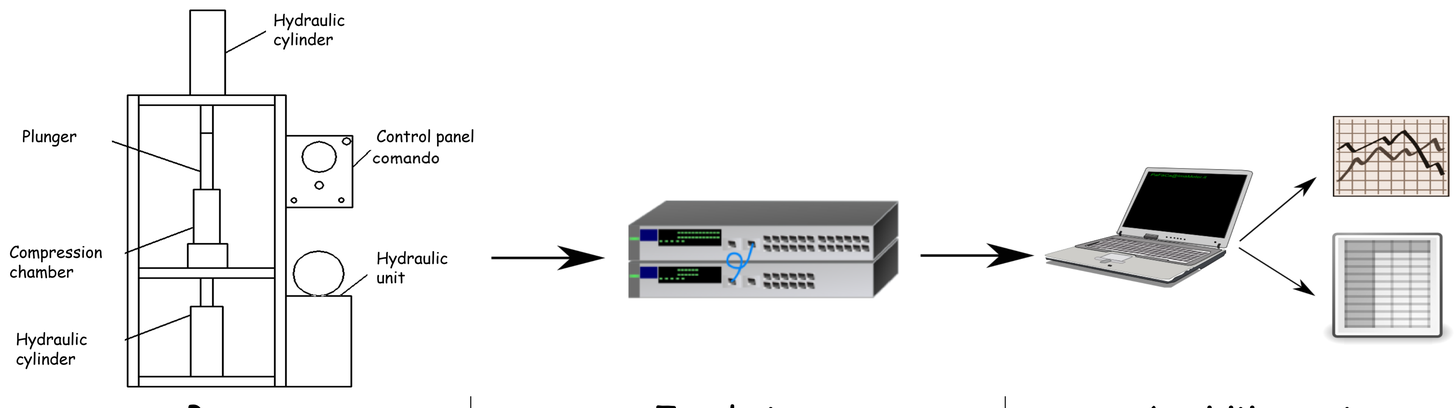


This research reports the results of a first investigation on physical behavior of compost derived from swine solid fraction during pressure agglomeration in a cylindrical die.

Materials and methods

Two different types of materials have been used → Swine Solid Fraction Compost (SSFC); Wood Chips Compost (WCC)

The initial bulk density values (ρ_0) were 250 kg·m^{-3} for SSFC and 450 kg·m^{-3} for WCC.



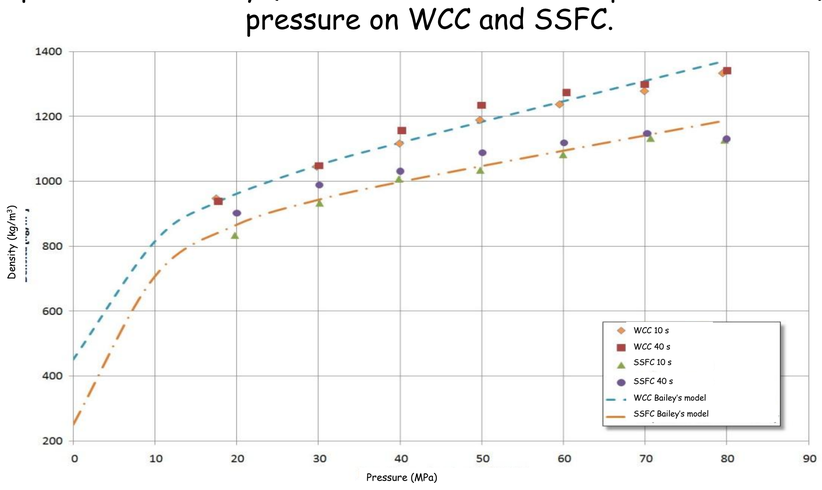
Press	Trasductors	Acquisition system
Max material pressure: 187 MPa	Strength: load cells 200 kN Max	N°4 analogical channels
Max volume chamber: 440 cm^3	Position: potentiometer 0÷500 mm	Sample rate up to10 ks/s
Time agglomeration : 1÷210 s	Pressure: 0÷250 bar (oil)	

The investigation was carried out using a prototype hydraulic press equipped with measuring sensors to record the variables influencing the densification process.

Seven levels of compaction pressure between 20 MPa and 80 MPa and two application times for each pressure level (10 and 40 s) were considered.

Results

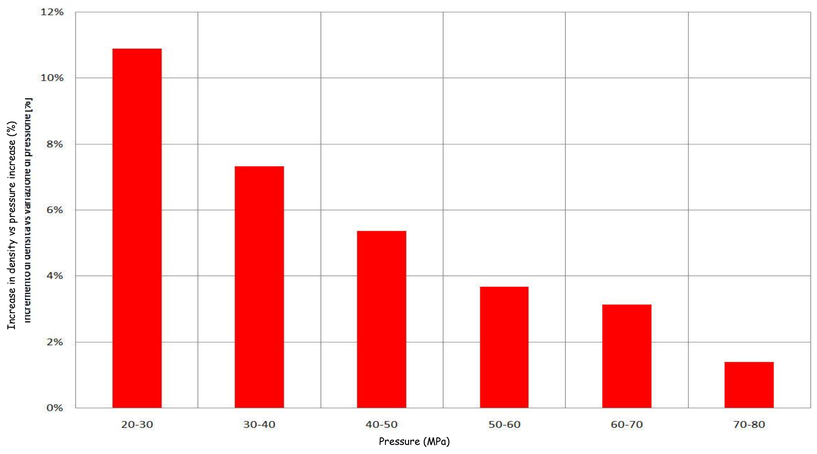
Relationship between density (theoretical values and experimental data) and applied pressure on WCC and SSFC.



In the range of pressure up to 10 MPa the density increase is linear.

In the second phase of compression (from about 10 MPa to about 80 MPa) the density increase is distinctly non linear and different for WCC and SSFC.

Average increase in density refers to pressure increase.



The tests performed showed that the density material increase diminishes when the pressure applied raises.

Average density values (kg·m^{-3}) of WCC and SSFC materials obtained using different pressure levels (20, 30, 40, 50, 60, 70 and 80 MPa).

Material	Pressure [MPa]							P
	20	30	40	50	60	70	80	
WCC	964.19^a	1047.69^b	1136.56^c	1211.89^d	1255.44^e	1288.65^f	1337.66^g	***
SSFC	868.72^a	961.60^b	1042.23^c	1059.96^d	1100.84^e	1140.65^f	1129.15^g	***

*** Significant at the 0.01 levels of probability

$^{a, b, c, d, e, f, g}$ mean values for materials with different letters differ significantly (P<0.05)

Average density values (kg·m^{-3}) of WCC and SSFC materials obtained with two-time application of pressure (10 and 40 s).

Material	Time [s]		P
	10	40	
WCC	1167.35	1187.53	***
SSFC	1028.38	1058.24	***

***Significant at the 0.01 levels of probability

The data highlight significant differences between the two materials, the two timing of pressure application and the seven levels of applied pressure.

Conclusions

Although significant differences were found between the final density values obtained at different pressure levels, the densification process efficiency decreases when the applied pressure increases.

Further tests will be carried out with the aim of verifying the maximum pressure beyond which the increase in density of WCC and SSFC is not significant.