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Octabin filling process

To develop understanding of granulate thickening and octabin deformation during the filling process

ATO report no. B666/January 2003

Confidential

Aart Zegveld
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Aart Zegveld
Gerárd van den Boogaard
Martijntje Vollebregt

ATO B.V.
Agrotechnological Research Institute
Bornsesteeg 59
P.O. Box 17
6700 AA Wageningen
The Netherlands
Tel: +31.0317.475024
Fax: +31.317.475347

Octabin filling process

develop understanding of granulate thickening and octabin deformation during the filling process

PTL

Gérard van den Boogaard
Martijntje Vollebregt
Aart Zegveld

Contents

Project

Goal: develop understanding of granulate thickening and octabin deformation during the filling process

Current process:

- sinusoidal vibrations
- one frequency (16.33 Hz)
- adjustable amplitude (2-3 mm)

Vibration machinery of Van Overveld Machines B.V.

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Experimental setup

What has most impact?

Amplitude, frequency, partial filling?

Runs:

1 standard: 90% filling, 16.33 Hz, 2.5 mm ampl., vibrated until no further thickening.
2 partial filling: As 1 with 50% filling, filled to 90%, vibrated until no further thickening. Idem after filled to 100%.
3 higher frequency: As 1 with 32.6 Hz.
4 inner bottom: As 1 with an inner bottom.
5 smaller amplitude: As 1 with 2 mm amplitude.

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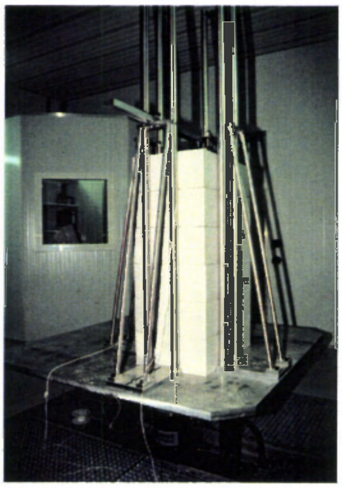
Experimental setup



Material:

Octabin: Duaboard Heavy

440 WS/200 SC/186 K/200 SC/440 WS (AA flute)

Granulate: EPS with density 0.65 kg/m^3

Vibration table:

Vertical vibration test system

(Lansmont Corporation, Model 7000-10 TTV)

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Experimental setup

Measurements:

- height of granulate to top of octabin
- deformation at 6 different heights along 2 opposite side walls (at pallet level, repeatedly 32 cm higher until top of octabin is reached)
- time of occurrence of side wall bends

Times of measurements:

- granulate height after filling
- granulate height and deformation after placement on vibration table before vibrations
- granulate height and deformation after placement on vibration table after repeated vibration periods

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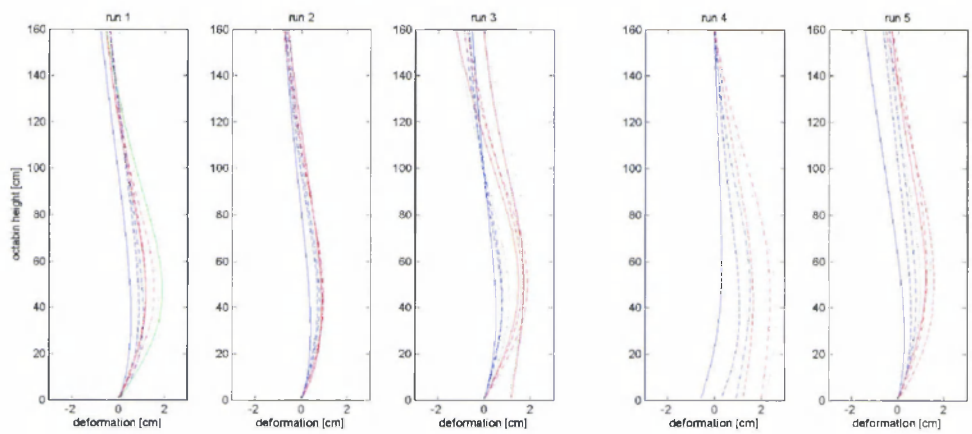
Octabin deformation



Order in time: blue (-,- -,...,-.), red (-,- -,...,-.), green.

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Octabin deformation

First occurrence of bend

All bends occurred, eliphant foot

Non-glued inner bottom: deformation outside pallet

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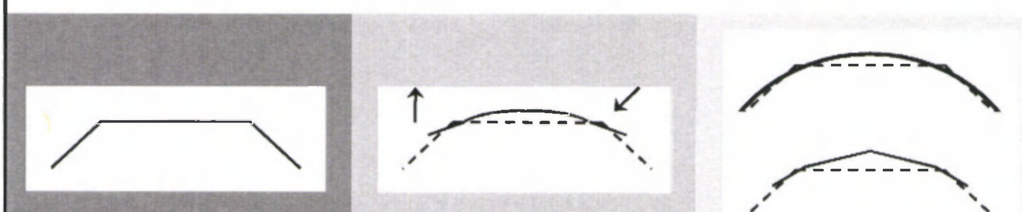
Octabin deformation

Theorem: optimal form with given perimeter and largest area is a circle

- Area octabin (side walls 0.45 m): 0.978 m^2
- Area circle with same perimeter: 1.032 m^2 (5.5% increase)



Middle of side wall moves out, corners move in.

Optimal:Deformation to a circle. Practice: bends occur (smaller area).

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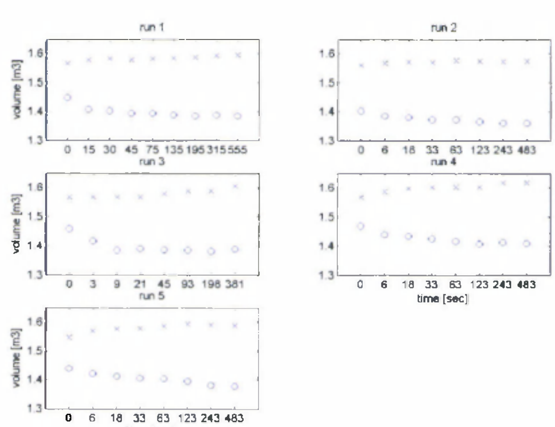
Granulate thickening



There is no initial measurement done of the octabin deformation.

Lowering of granulate level directly after placement on the vibration table is at most 2 cm.

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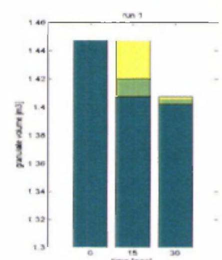
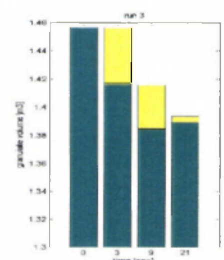
Granulate thickening

Theoretical influence on granulate height:

	granulate volume	
octabin volume	**smaller**	larger (bends)
smaller (bends)	+/-	does not occur in experiment
larger	**decrease**	+/-





dark green: granulate volume
light green: octabin deformation
yellow: granulate thickening

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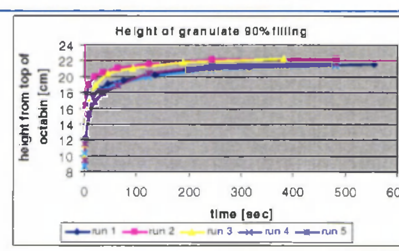
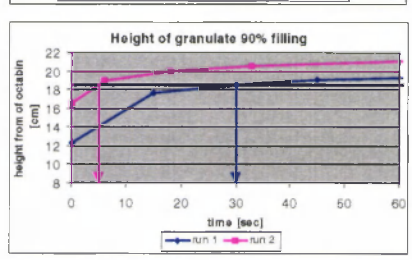
Granulate thickening

When can last shot (100 kg) be added?

Assumption: 2 cm additional space (enough?)

	time [sec]	max deform. [cm]
run 1 standard	30.0	1.1
run 2 partial filling	11.7	0.7
run 3 higher frequency	18.2	1.0
run 4 inner bottom	41.3	1.7
run 5 smaller amplitude	50.2	1.1





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Summary experimental results

From least to most time needed before last 100 kg can be added:

- partial filling (time of total process?)
- higher frequency
- standard
- inner bottom
- smaller amplitude

From least to most deformation before last 100 kg is added:

- partial filling (time of total process?)
- higher frequency, standard, smaller amplitude
- inner bottom

Effects of combination of thickening processes?

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Conclusions

At the moment that 100 kg can be added:

- Partial filling leads to least deformation and fastest thickening
- Larger frequency leads to standard deformation and to faster thickening
- Smaller amplitude leads to standard deformation and to slower thickening
- Inner bottom leads to most deformation and to slower thickening

In case of more required thickening:

- Larger frequency leads to more deformation than standard process
- Smaller amplitude leads to less deformation than standard process

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Additional results

Conduction of project resulted also in:

- reference set of test runs for ATO equipment (to compare effect on other octabins and / or granulate)
- current experimental setup is sufficient to compare thickening recipees (with the addition of initial octabin deformation measurements)
- several Matlab functions to analyse and visualise the results

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Potential further research

Further research:

- When is a certain octabin deformation or granulate thickening reached?
- What is the behaviour for other types of octabins or other granulates?
- What is the effect of filling recipees on long term storage behaviour?
- Can the filling recipee be optimised to minimise octabin material?

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