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I-PAN

INNOVATIVE POPLAR LOW DENSITY STRUCTURAL PANEL

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D7.1 – Dust forming technologies

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Document information

Abstract

In the present task it will be studied and developed a suitable 0,2-0,5mm thick layer to apply on the mat of the finished boards. Wood dust shall need to be produced in the mills and screened out in order to obtain the proper size. Resins shall be then applied to the dust and they will be placed continuously on the top and the bottom of the mat in order to obtain a uniform surface. Moreover such a layer should allow the surface of the mat to be laminated with different coatings.

Keywords

Wood, dust, spreader, sieve, gap, particle size, dosage, density, moisture

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* Abbreviations of editor/contributor name

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INTRODUCTION

In the present Task it will be studied and developed a suitable 0,2-0,5mm thick layer to apply on the mat of the finished boards. Wood dust shall need to be produced in the mills and screened out in order to obtain the proper size. Resins shall be then applied to the dust and they will be placed continuously on the top and the bottom of the mat in order to obtain a uniform surface.

Moreover such a layer should allow the surface of the mat to be laminated with different coatings.

The purpose of the report is to demonstrate that it is possible to obtain a layer of 0.2-0.5 mm OSB panel and reducing energy costs.

1 RAW MATERIAL AND MANUFACTURING CHARACTERISTICS

The characteristics of the powder to form the outer LSB are:

Dry material:

- Density: 200 kg / m³
- 3% moisture
- Grain size: <0.3 mm (Ergo, everything that passes through a mesh 0.3 x 0, 3mm)

Before reaching the formation of chemical compounds are added in resin bonder:

- MUF glue (melamine 20%, solid content 65%): max 15% dry content with respect to the flow rate of dry wood.

- Hardener (generally used ammonium sulfate to 25% concentration): in relation to the type of glue, it is usually 0.3% of the dry content, compared to the flow of dry wood.

- Paraffin emulsion (55% solids): max 5% dry content with respect to the flow rate of dry wood.

Forming the outer layers of wood dust recovered from the process (at different stages of chipping, surface grinding, etc...

Originally the forming machine consisted of a conveyor belt installed on a forced air system, the particles precipitate since the top step and it falls on the air jet which causes an acceleration of the particles, precipitating in those particles forming belt lighter and heavier particles are sent to a more distance than the rest of particles.

While lighter weight particles are the first to fall into the conveyor belt which form the 5-layer blanket, thus starting the first outer layer.

The particles that we will deal with the machine forming dust layers (outer sides) have a size between 0.3 and 0.5 mm.

Air forming today is still a highly efficient but involves aspects that hinder their application in the design required for the panel i-pan, these include:

• High investment costs.

• High costs of maintenance.

• Greater complexity of regulation and adjustment.

• Significant decrease in production when altering the parameters of the input material.

• Bulky in mechanical dimensions implantation.

• Forming in the crosswise.

2 SIMILAR OPERATING PRINCIPLES

DUST HANDLING TECHNOLOGIES

This chapter discusses the similar operating principles and existing equipment. In successive chapters provides an assessment of these technologies and concludes by explaining the viability and functioning expected for the new design powder dosing.

ANTECEDENT SPREADER SCREW AND ROTARY PLANAR VALVE WITH DECOMPRESSION

A spreader truck having a vessel for storage of a volume of powdered material is disclosed. A dust collector is mounted on the spreader truck such that airborne particles are collected as particulate material is spread over a subgrade or roadway. Filter media in the dust collector serves a dual purpose of collecting dust through a vent opening when the vessel is being loaded and collecting dust adjacent the outlet opening when the powder is being dispensed on to a subgrade.

Highlights: Bulky, high moving parts, lack of control over dosage and difficulty in regulation.

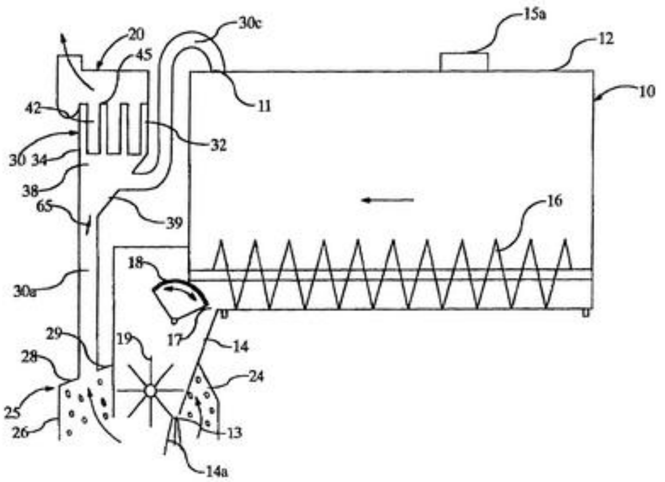
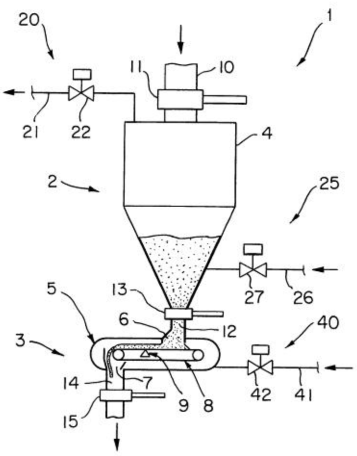


Figure 1 – Example Dust spreader screw and rotary planar valve with decompression

ANTECEDENT MULTIPLE DUST DOSAGE CONVEYOR

A granular material supply system has a granular material supply unit and a granular material feed unit. The granular material supply unit delivers a granular material through an inlet formed in a pressure case included in the granular material feed unit onto a conveying device disposed in the pressure case. The conveying device conveys the granular material to an outlet formed in the pressure case to feed the granular material through the outlet into a granular material using apparatus. The granular material supply unit and the pressure case of the granular material feed unit can be immovably installed. Therefore the granular material supply system can be formed in a closed system without placing any special joints, such as expansion joints, in a line connecting the granular material supply unit and the pressure case and in a line connecting the pressure case and the granular material using apparatus. Only the conveying device needs to be disposed in the pressure case. Thus the granular material supply system is very simple and small in construction and is not very tall, which is advantageous in space for installation and equipment investment.

Highlights: Bulky, high moving parts, lack of control over dosage and difficulty in regulation.



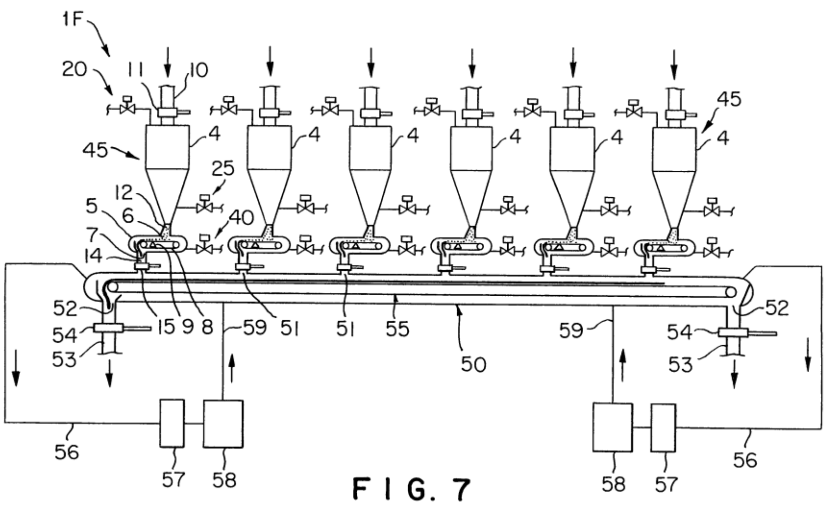


Figure 2 – Example multiple dust dosage conveyor

ANTECEDENT ROLLER PARTICULATE FORMER

The spreading apparatus has a main hopper and at least one extension hopper, each having a discharge roller for flow able material such as chippings for road surfacing. The extension hopper is mounted adjacent the main hopper and movable longitudinally to enable variation of the combined width of the hoppers. A baffle cuts off communication between the discharge roller of the extension hopper and the major part of the interior of the extension hopper over a width corresponding to the longitudinal overlap between the main hopper and the extension hopper.

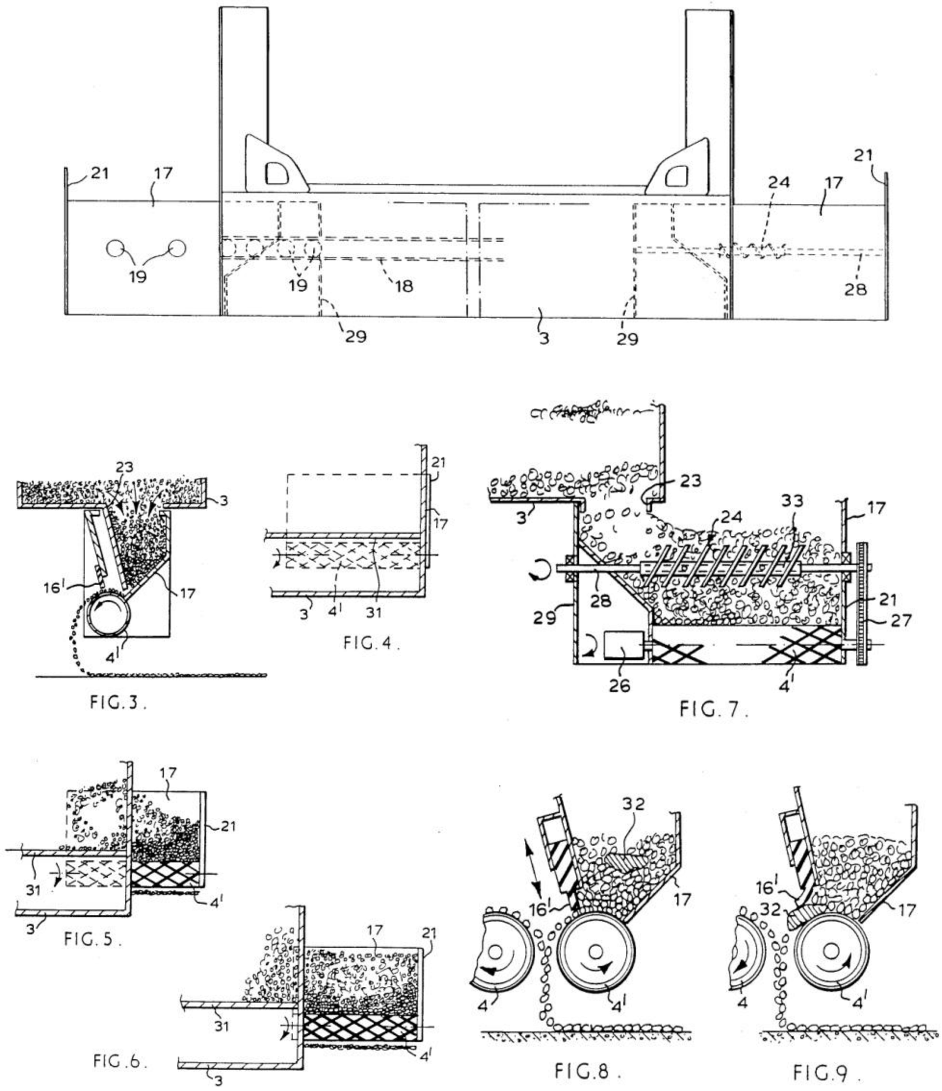


Figure 3 – Example roller particulate former

CURRENT SYSTEMS OF PARTICLE FORMING FOR WOOD BASED PANNELS

2.1.1 SERVICE-PROVEN MAT FORMING (WINDFORMER)

The face layer WindFormer uses a current of air to separate the particles into coarse fractions near the air nozzles for the core layer and finer particles – according to their size – at the rear end of the wind chamber for the face layer.

The air current can be controlled for the entire system or for individual groups of nozzles. Optimal distribution and exact size separation of the particles are assured by screens, some of them fitted with vibrators. The coarse fraction is discharged by a vibrating screen and a discharge screw.

Technical features

• High degree of separation

• Precise mat forming

• Adjustable separation

(coarse/fine particles) as required.

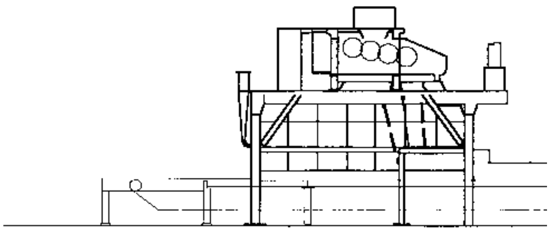



Figure 4 – Face layer wind forming system. Partial view of the complete particle mat forming system

2.1.2 SYSTEMS FOR PARTICLEBOARD (CAGEFORMER)

The core layer CageFormer has a mechanical mat forming head with distribution rollers to produce two product flows.

Doffing rollers for breaking up the material convey the particles continuously to the cage rollers, which deposit the mix – without further size separation on the underlying forming belt.

Technical features:

• Homogenous particle mix, with no porosity in the core layer

• Consistent particle size distribution plus high forming accuracy

Customer benefits of the mat forming system:

• Finest face layers for top-quality laminating or direct painting

• Low glue consumption

• High internal bond thanks to the homogeneous core layer

Particle throughput per meter forming width (Wind/CageFormer) approx. 90 – 170 m^3/h

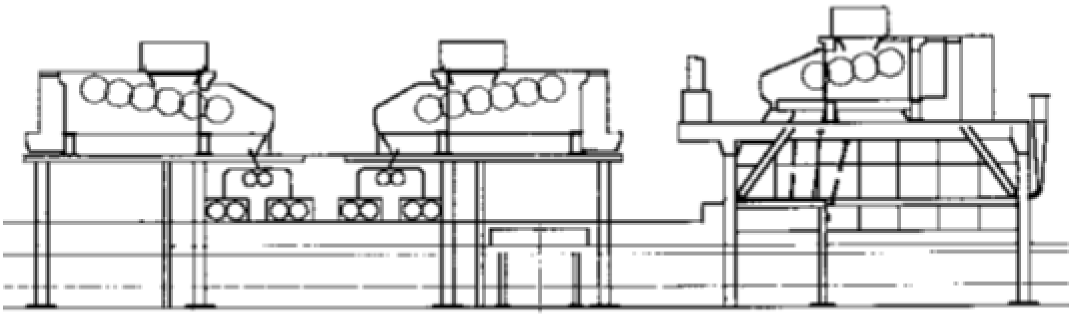


Figure 5 – Plant Layout CageFormer system

2.1.3 CROWNFORMER

The face and core layer CrownFormer machines are equipped with patented, mechanical disc orienteers. The face layer CrownFormer has a pre-separating unit (patent pending) for the upper row of rollers, which produce a uniform material flow and feed the underlying row of rollers, i.e. the main separating unit.

Particle throughput per meter forming width (Crown/CrownFormer) approx. 65 – 200 m^3/h

Figure 6 – Face layer CrownFormer. Partial view of the complete particle mat forming system

2.1.4 FORMING SYSTEM FOR PARTICLEBOARD COMBINED (CROWN/CAGEFORMER)

The number of toothed rollers in this unit determines the capacity of the plant. The feed clearance between the toothed rollers guarantees a structured mat build-up based on fine and coarse particles. Fine particles end up in the face layer while the coarse particles are directed to the middle of the mat. A gentle current of air underneath the separating unit enhances this process. Excessively large particles are rejected by a discharge screw.

A "TwinMech" unit consisting of two special CageFormers can be used with each material bunker for particularly high throughput requirements. No additional dosing bunkers or loading units are needed.

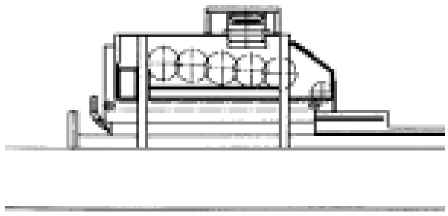


Figure 73 – Example of "TwinMech" unit

A further option is to combine a CrownFormer for the face layer with a CageFormer for the core layer. Such a system combines the advantages of a mechanical face layer mat forming system with the CageFormer's excellent mixing of material for the core layer. The result is a particleboard with a fine surface, tight edges and very good internal bond – all provided by mat forming units of low overall height.

Particle throughput per meter forming width (Crown/CageFormer) approx. 60 – 200 m^3/h

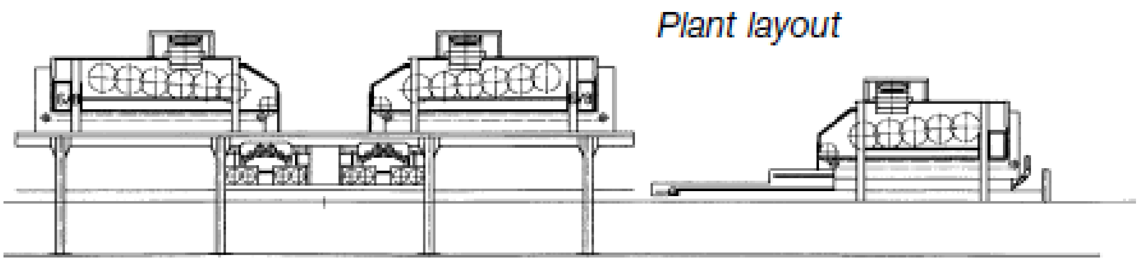


Figure 8 – Partial Plant Layout Crown/CageFormer system

The core layer CrownFormer uses a bed of identically finished toothed rollers to spread a homogeneous mat on top of the first face layer mat while at the same time ensuring that enough fine material reaches the core of the mat to act as binder. Excessively large particles are rejected via a belt conveyor.

Technical features:

The face layer CrownFormer:

• Good separation with highest mat forming precision

The core layer CrownFormer:

• Low separating effect with high mat forming precision

The CrownFormer in general:

• Self-cleaning mat forming rollers
• Low overall height
• No need for a disc screen

Customer benefits of the mat forming system:

• Material cost savings
• Low building costs for halls and steel structures
• Low maintenance costs

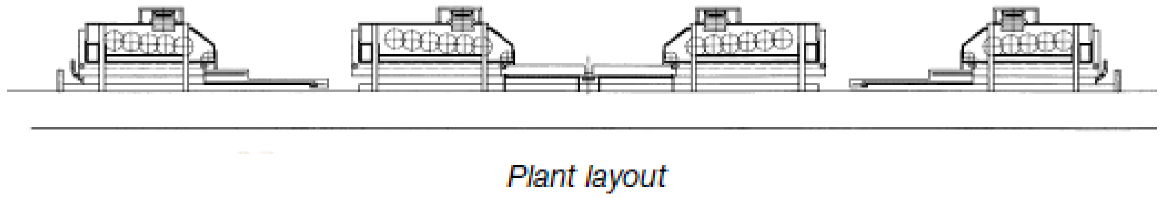


Figure 94 – Plant Layout Crown/CageFormer system

2.1.5 FORMING SYSTEM FOR PARTICLEBOARD WITH DISINTEGRATION ROLLERS AND BUNKER

In this design the material is fed from the mat forming bunker by means of a bottom dosing belt and disc rollers in the bunker discharge front. Fibre is conveyed by two patented disintegration rollers to the new mechanical mat forming head consisting of toothed rollers. The pitch and speed of these rollers can be varied to control the feed rate and ensure that the fibre is distributed uniformly over the mat forming belt in transverse and longitudinal direction. Both the angle of tilt and height of the mat forming head are adjustable. Downstream from the mat forming head is a leveling head with a variety of leveling rollers. Its function is to produce a uniform mat with constant weight per unit area independently of the mat height and bulk density.

Technical features:

• High mat forming precision and best distribution of weight in transverse and longitudinal direction thanks to the homogeneous distribution of fibre and density in the mat

• Optimal distribution of fibre in the mat forming head enables a controlled mat forming process

• A leveling head instead of a scalper roll means there is no longer any need for fibre recycling at the mat forming machine, thus reducing the number of pneumatic transport systems

• Lower electricity consumption

• Large mat forming bunker replaces a fibre bunker

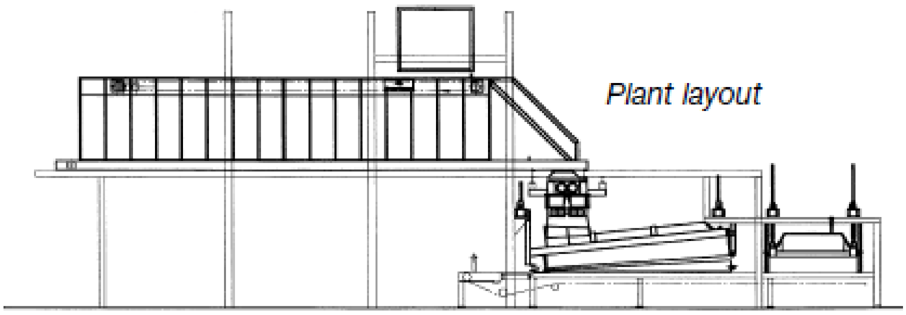


Figure 50 – Plant Layout of system

Figure 61 – Mat forming head with disintegration rollers

1 DESIGN OF DUST SPREADER

MACHINE DESIGN

This section is a description of the advantages and conclusions of metering equipment design wood dust.

The main highlights are:

- Minimum energy consumption because not require fan or turbines for particle projection.
- Easy and multiple adjustments of the gap to improve the spreader operation.
- Maximum control of dust emission (de-dusting flanges).
- Low maintenance costs.

Hopper concept design, top mounted and minimum size.

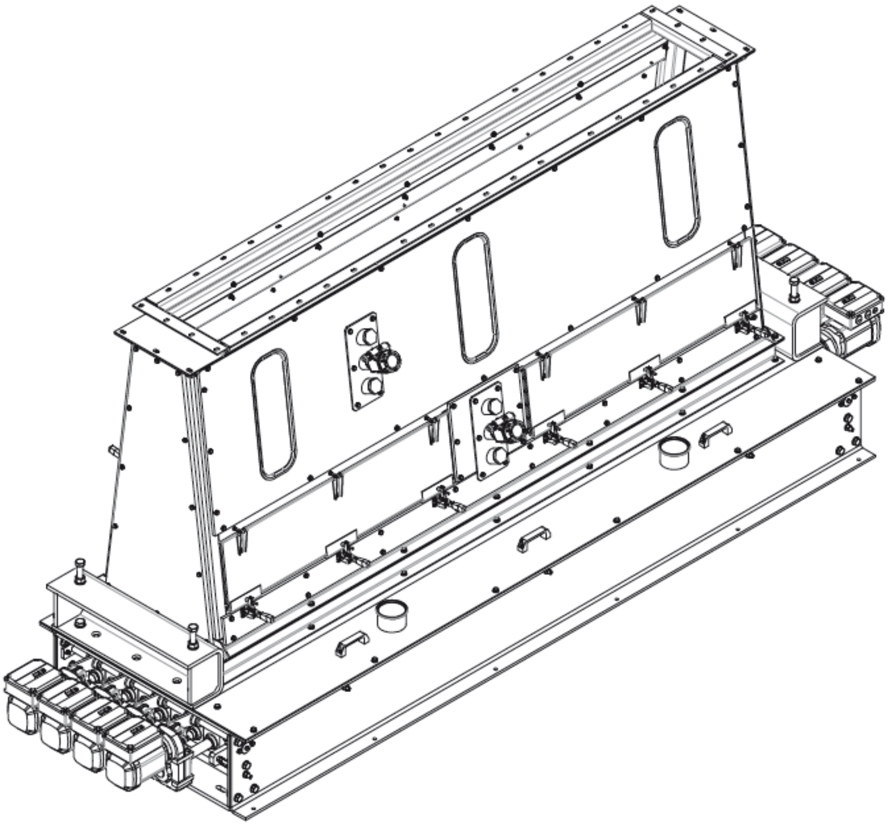


Figure 12 - Dosage to full conveyor width

Bottom view of roller parts

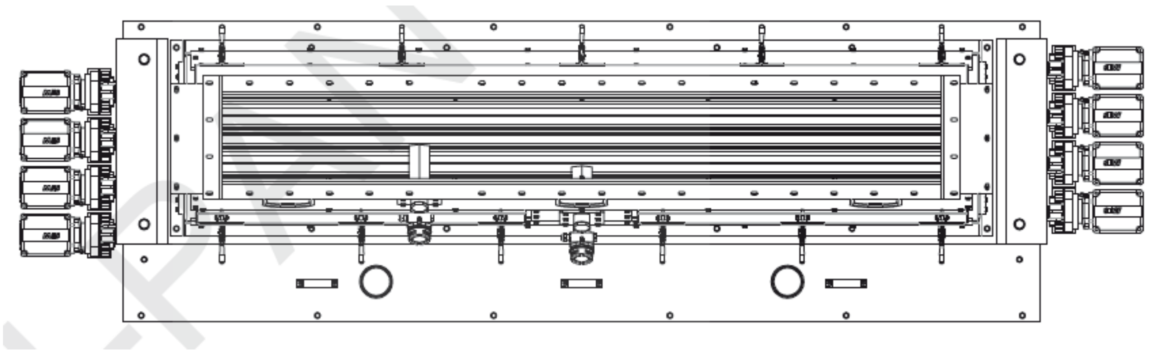


Figure 13 - Capacity gap adjustment for better dust forming of the outer layers

Roller gears adjustment scrolls

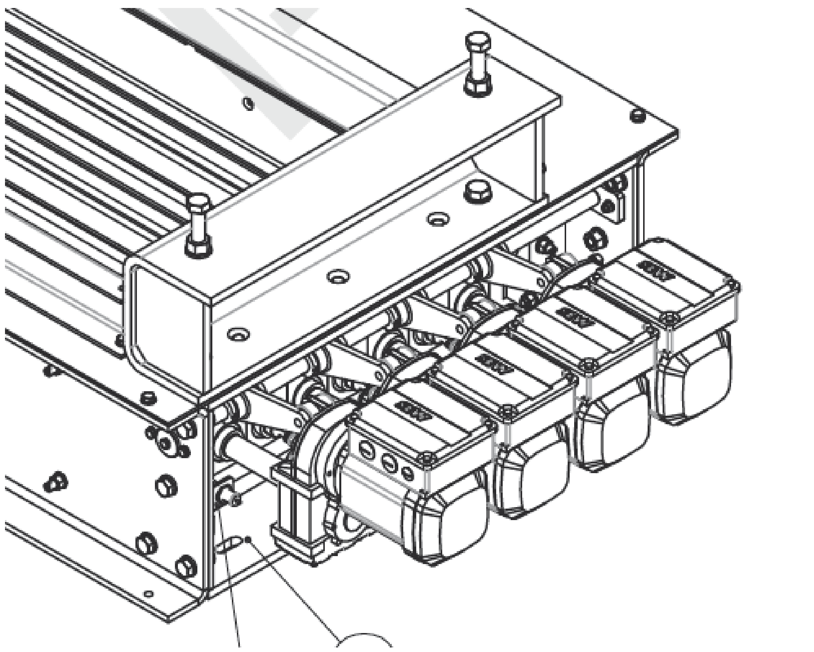


Figure 14 - Longitudinal scroll for gap adjustment for better dust forming of the outer layers

Easy flat integration between equipments of mat forming

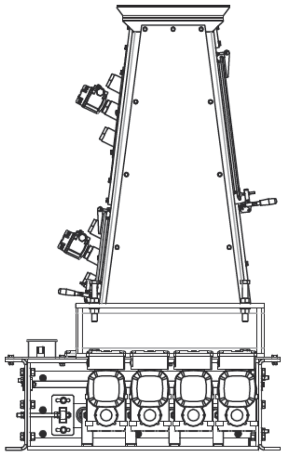



Figure 15 - Minimizing of parts and mechanism

Fine control of levels and laminar flow

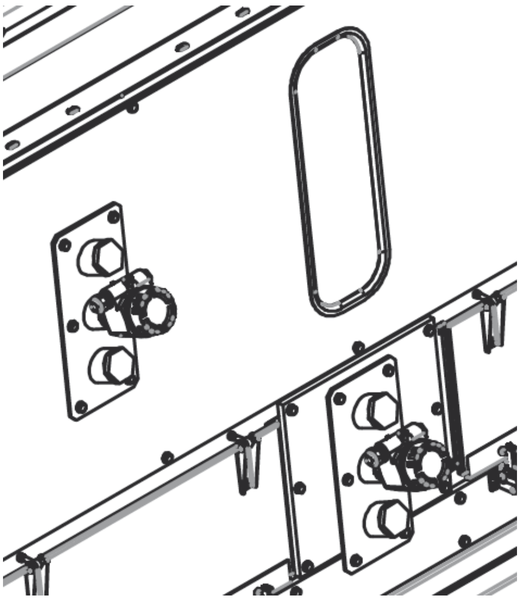



Figure 16 - Minimizing of electrical parts and instruments

MACHINE INTEGRATION

According to the general layout, these formers will be integrated in the next positions:

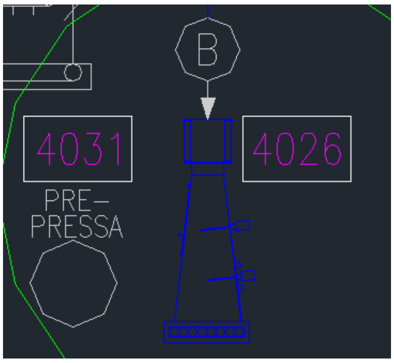


Figure 17 – Elements 4026 and 4031

When the material leaves of the machine 4026, the material goes to the element 4031 (Prepressa).

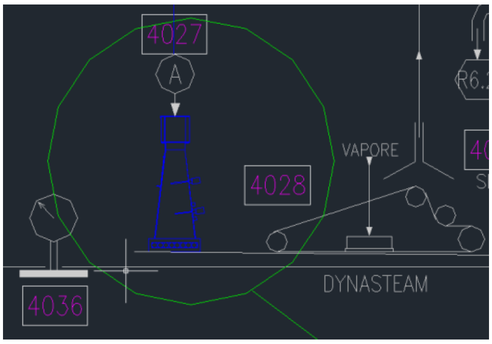


Figure 18 – Elements 4027, 4028 and 4036

The material that coming from the machine 4026, before reaching the machine 4027 it pass through the element 4028, called Dynasteam and then, in the exit the machine 4027, the material goes to element 4036.

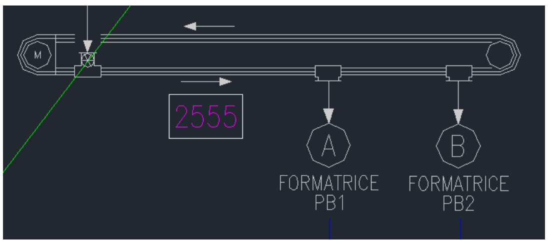


Figure 19 – Elements 2555, Formatrice PB1 and Formatrice PB2

The material that will to enter into the machines 4026 and 4027, before it reaching the Formatrices, it passes through the element 2555.

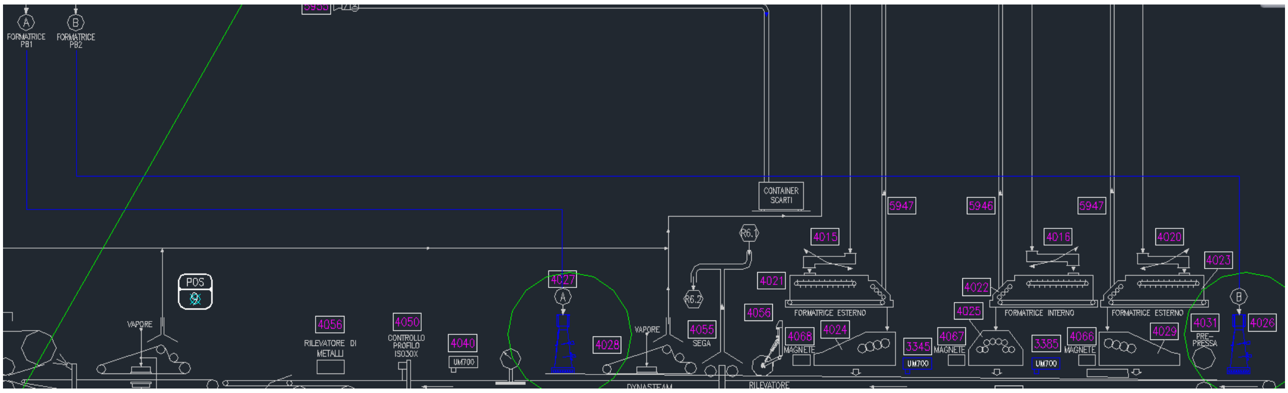


Figure 70 – Connection between Formatrices PB1 and PB2**,** and **elements** 4026 and 4027

This image shows the connection between the material from the leaving of the Formatrices until it enters in machines 4026 and 4027, and as you can see, the machine 4026 receives the material of the Formatrice PB2, and the machine 4027 receives it of the Formatrice PB1.

2 EQUIPMENT OVERVIEW AND FEATURES

EQUIPMENT OVERVIEW

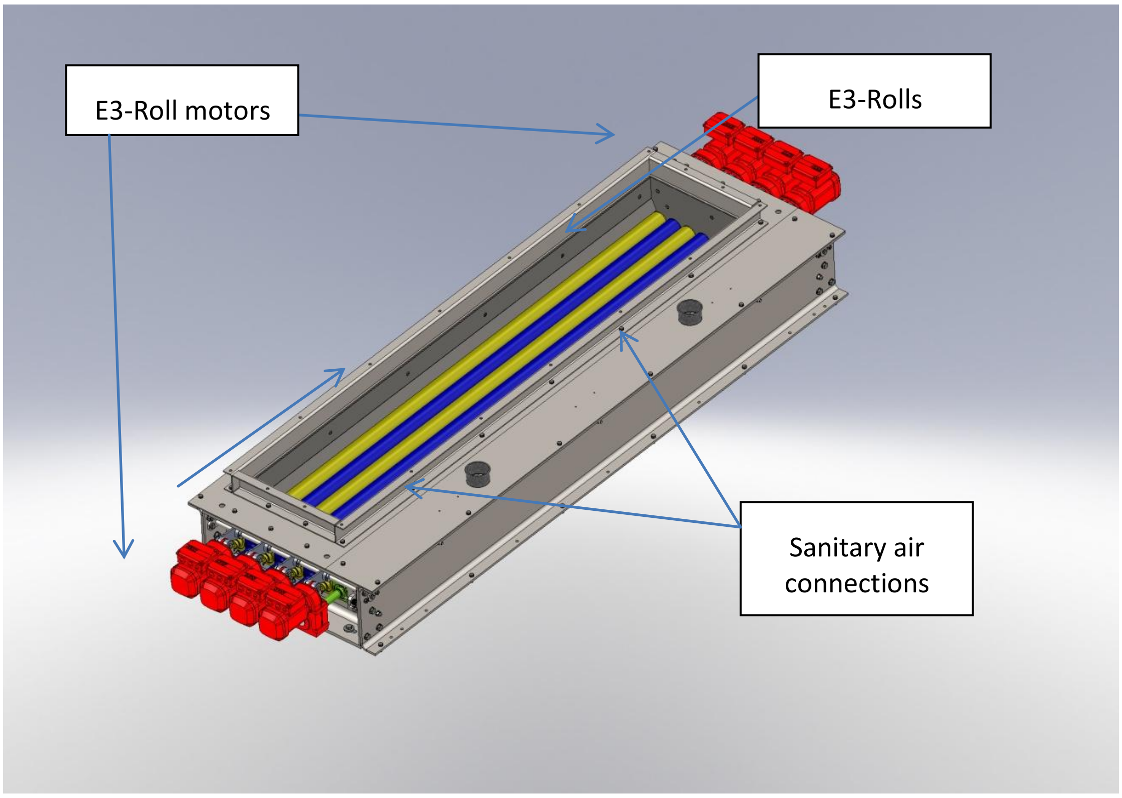


Figure 81 – Bottom of equipment

Installed power	8 x 0,37 kW = 2,96 kW
Total number of E3 rolls	8 pieces (7 with pattern, one smooth)
Diameter of E3 rolls	80 mm
Rotation speed of E3 rolls	50 – 160rpm
Forming with	2700 mm
Equipment weight	1.850 kg (information obtained from the modeling).

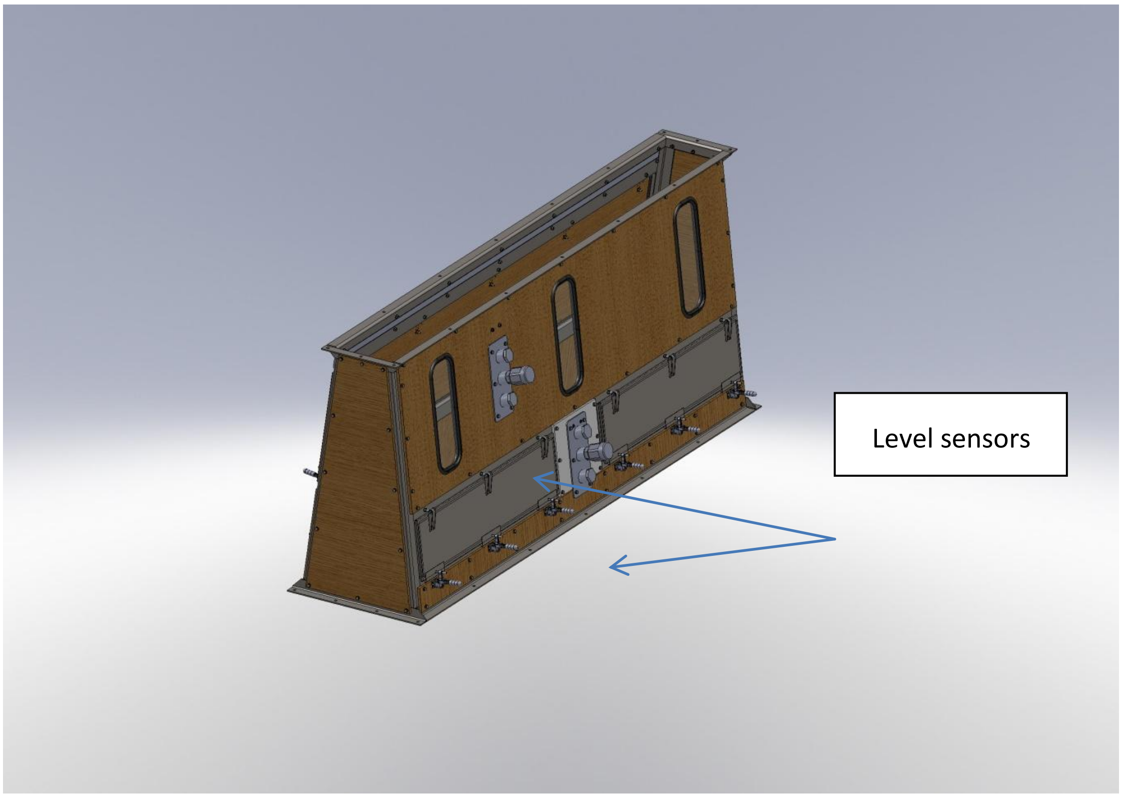


Figure 92 – Feeding bin

Bin nominal width	2700 mm
Level sensors (if installed)	Soliphant FTM50-3GG2A4A32AA
Overlaid plywood walls	
Inspection doors and windows	
Connections for level sensors	

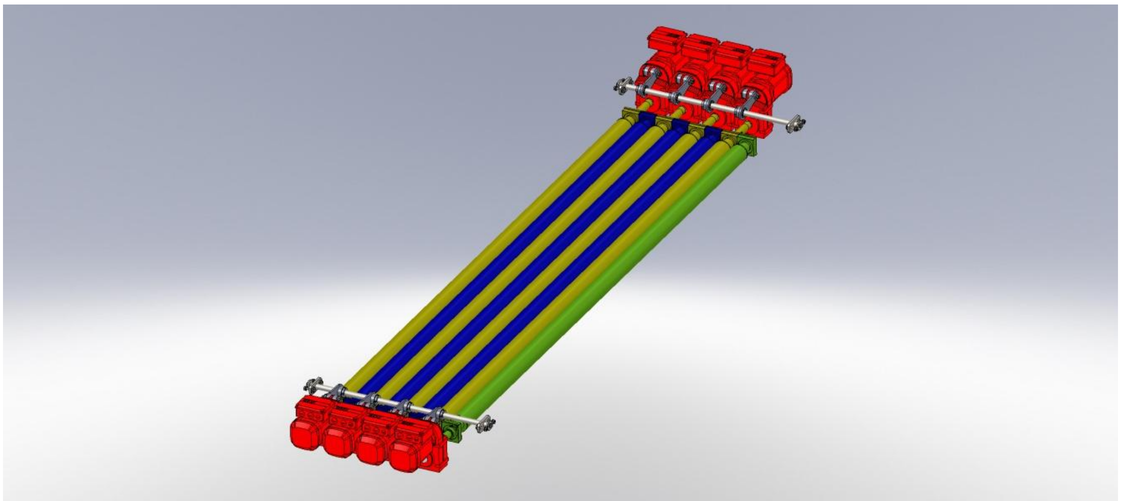


Figure 103 – Direct driven rolls

Forming width	2700 mm
Roll surface treatment	hard chrome
Roll OD	80 mm
Roll pattern / quantity	1,5 mm / 7 pcs, smooth surface/1 pc
Roll drive motor	Shaft designed with gear motors SEW FA27 II2GD/GEDRS71M4/3GD/TF/AL

3 AJUSTMENTS

ROLLER ROTATION SPEED ADJUSTMENT

- Roller rotation speed can be adjusted from HMI of I-PAN control process.
- Rotation speed can be between 25-200 rpm.

GAP SETTING

- Turn off the safety switch
- Measure the roll gap between the rolls in both ends
- Loosen the compression of locking device springs of roller bed
- Replace shim plate with thicker shim plate or add shim plates if you need to increase the gap. Shim plates are located between the roll bearing housings.
- Replace shim plate with thinner shim plate or remove shim plates if you need to decrease the gap. Shim plates are located between the roll bearing housings.
- Tighten the compression of locking device springs of roller bed
- Check roll gaps and make sure that rolls are rotating free
- Turn on safety switch

Minimum recommended gap setting is 0.5 mm to avoid rolls clashing.

Replace side plates if you have to adjust roll gaps beyond the adjustment range of original side plates.

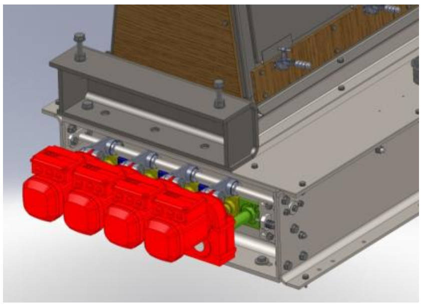


Figure 2411 – Locking device springs

ROLL CHANGE

- Turn off the safety switch
- remove sealing plates
- loosen roller bed locking devices from the rear part of the roller bed

- remove drive motor from the shaft
- remove shim plates of the roll to be removed
- Remove bearing unit from one shaft end.
- remove E^3 roll pulling from the side of the former
- install bearing unit to one shaft end of new roll
- install new roll from the side of the former, be carefull with the roll when installing
- install bearing unit to the other shaft end of new roll
- install shim plates and gear motor
- tighten roller bed tightener
- Check roll gaps
- install sealing plates
- make sure that rolls are rotating free
- Turn on safety switch

ROLL SCRAPER ADJUSTMENT

Scraper shall be adjusted so that it touches the smooth roller without compressing it.

6. CONCLUSIONS

The main conclusions of the research and development of new forming machine outer layers of dust for I-PAN project has allowed us to bring together the best capabilities of the equipment usually applied in projects related to the treatment and management of dust as happens with solid fuels, cement, minerals, waste (solid recovered fuel) etc..

7. DRAWINGS

DRAWINGS IN A2

DRAWING	DESCRIPTION
G01	General Assembly
A01	Base Blade Structure
A02	Hopper Dust Forming
A03	Necklace

DRAWINGS IN A3

DRAWING	DESCRIPTION
101	Regulator Bolt
102	Regulator Bolt
103	Structure Side
104	Structure Side 2
105	Structure Cover
106	Hopper Base
107	Profile C 2800
108	Profile C 565
109	Plastic Ring
110	Roller Blades
111	Interior Protection
112	Lock

113	Engine Rod
114	Engine Base
115	Engine Base 2
116	Inner Sheet
117	Deflector
118	Lower Guide
119	Lower Guide
120	Top Guide
121	Top Guide
122	Bridle
123	Support Rod
124	Threaded Rod M12
125	Washer
126	Arm
127	Short Detector Support
128	Detector Support
129	Long Detector Support
130	Torque Arm
201	Structure
202	Side
203	Windows Lower Wood
204	Windows Lower Wide Wood
205	Top Wood
206	Windows Top Wood

207	Detector Support Wood
208	Small Window
209	Large Window
210	Detector Plate
211	Detector Protection
212	Plug 1-1/2”
215	Hinge
301	Short U
302	Long U

8. SPARE PARTS

In this chapter we proceed to describe the equipment and external drives the design described in the process.

GEARMOTOR

SUPPLIER : SEW-EURODRIVE

UNIT DESIGNATION: FA27 112GD-G-EDRS71M4-3GD-TF-AL

- FA: Gear unit type -> Parallel shaft helical gearmotor with hollow shaft
- 27: Gear unit size
- 112GD: Gear category -> Explosion-proof design to directive 94/9/EC
- G: with rubber buffer (optional)
- DRS: Motor series -> Motor, Standard efficiency 50Hz
- 71M4: Motor size and number of poles
- TF: Thermistor sensor (optional)
- Mounting position of AC Motor -> V18

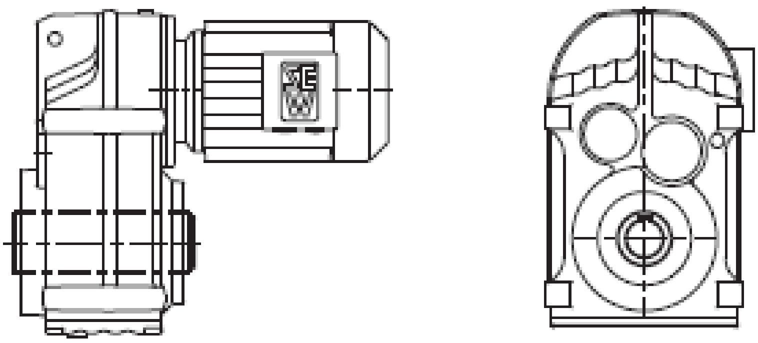


Figure 25. Gear

LEVEL LIMIT SWITCH

SUPPLIER: SOLIPHANT

UNIT DESIGNATION: FTM50-3GG2A4A32AA

- 3: ATEX II 3 D, ATEX II 3 G EEx nA/nL/nC
- GG: EN10226, R 1½
- 2: 316L; Ra 3.2 µm/80 grit, *[1] (without) fork polished
- A: 155 mm/6 in; min. 10 g/l (0.7 lbs) -> Bulk density with standard fork
- 4: FEM54; DPDT, 19...253 V AC/55VDC
- A: Compact
- 3: F17, Aluminium, IP66/67 NEMA4X
- 2: M20
- A: *[1] (without) Glass cover
- A: *[1] (without) Temperature spacer

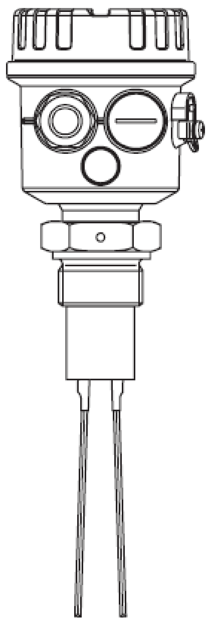


Figure 26. Level switch

10. WOOD DUST PROPERTIES

Possible result of sieve analysis:

POS.	# mm	gr.	% ass.	% prog.
1	>1,34	0,73	7,45	7,45
2	>1,27	0,63	6,43	13,88
3	>1,00	1,85	18,88	32,76
4	>0,60	2,55	26,02	58,78
5	>0,40	1,74	17,76	76,54
6	>0,30	0,53	5,41	81,95
7	>0,23	0,49	5,00	86,95
8	>0,15	0,42	4,29	91,24
9	<0,15	0,86	8,78	100

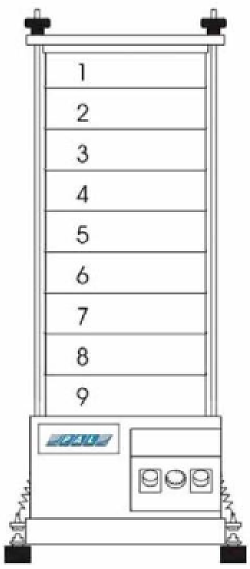


Figure 127 – Example of sieving machine designed for wood chips and wood strands

FEATURES OF VARIOUS DIMENSIONS OF DUST GRAINS

WOODEN DUST – BIA REPORT 13/97

Particle Size:	<10
TMI c (*):	280
TMI n:	330
LIE g/m3:	125
EMI mJ:	>1000
CLO %:	10
Kmax bar m/s:	113
Pmax bar g:	8,6

WOODEN VARNISHED

Particle Size:	19
TMI c (*):	320
TMI n:	460
LIE g/m3:	60
EMI mJ:	45
CLO %:	-
Kmax bar m/s:	151
Pmax bar g:	8,5

WOODEN DUST – 394 VTT PUBLICATIONS

Particle Size:	311
TMI c (*):	340
TMI n:	420
LIE g/m3:	30
EMI mJ:	60
CLO %:	10
Kmax bar m/s:	115
Pmax bar g:	8,8

WOODEN PEAR

Particle Size:	27
TMI c (*):	300
TMI n:	400
LIE g/m3:	30
EMI mJ:	-
CLO %:	-
Kmax bar m/s:	205
Pmax bar g:	10,5

WOODEN SPANISH PINE 394 VTT PUBLICATIONS

Particle Size:	247
TMI c (*):	350
TMI n:	460
LIE g/m3:	90
EMI mJ:	450
CLO %:	17
Kmax bar m/s:	44
Pmax bar g:	8,2

WOODEN FROM HOUSE BAG FILTER DUST -MUNDOATEX

Particle Size:	32
TMI c (*):	320
TMI n:	440
LIE g/m3:	30
EMI mJ:	24
CLO %:	-
Kmax bar m/s:	142
Pmax bar g:	8,1

WOODEN FROM SIEVE FINES - MUNDOATEX

Particle Size:	166
TMI c (*):	340
TMI n:	440
LIE g/m3:	125
EMI mJ:	>1000
CLO %:	-
Kmax bar m/s:	103
Pmax bar g:	7,7

WOODEN FROM SANDER PROCESS#1 - MUNDOATEX

Particle Size:	197,9
TMI c (*):	340
TMI n:	460
LIE g/m3:	60
EMI mJ:	260
CLO %:	-
Kmax bar m/s:	65
Pmax bar g:	7,5

WOODEN FROM SANDER PROCESS#2 - MUNDOATEX

Particle Size:	42
TMI c (*):	330
TMI n:	440
LIE g/m3:	30
EMI mJ:	50
CLO %:	-
Kmax bar m/s:	167
Pmax bar g:	8,1

Figure 138 – Tables dimensional characteristics of various dust grains

11. NORMS AND REGULATIONS

Particles = UNE-EN 13284-1:2002. Stationary source emissions. Determining particles in low concentration. Part 1: Manual gravimetric method.

Aerodynamic diameter = VDI 2066, Blatt 5: 1994. Particulate matter measurement - Dust measurement in flowing chiffon, particle size selective measurement by impaction method - Cascade impactor

Equipment used:

Isokinetic equipment complete with titanium head for flat filter head quartz fiber.

Titanium impactor head for determining the aerodynamic diameter, Design Research Inc. Meteorology., Altadena (California) with glass fiber filters. Has been used a pre-separator for particles> 100 microns.

Digital Micromanometer pitote tube type S.

Emission Psychrometer with two thermometers PT100.

Digital temperature and type K probe.

- UNE-EN 26184-1:1993 Constant product feature (**Kmax)** Sphere 20 liters
  UNE-EN 14034-2

- UNE-EN 26184-1:1993 Maximum explosion pressure (overpressure) (**Pmax)**
  UNE-EN 14034-1

The values of Pmax and Kmax are determined each nominal concentration of dust in a test device consisting of a stainless steel hollow sphere of 20 liters capacity.

- UNE-EN 13821:2003 Minimum ignition energy (**EMI)**

The energy is calculated by the expression $E = ½ C U^2$. Minimum ignition energy is between the highest energy, E1, at which no ignition occurs in 10 successive attempts to ignite the dust-air mixture and flammable lower energy E2, at which ignition occurs in one of 10 sequential shots.

- UNE-EN 14034-3:2006 Lower Explosive Limit (**LIE)**

The test method consists in dispersing decreasing amounts of test sample in the 20 liter spherical vessel.

- UNE-EN 50281-2-1:1999 Minimum ignition temperature cloud (**TMIn)**

The test apparatus used for Tmin is a vertical cylinder electrically heated to a certain temperature, which causes the dispersion of the powder.

- UNE-EN 50281-2-1:1999 Minimum ignition temperature layer (**TMIc)**

The test device for measuring TMIC is a metal plate whose temperature can be varied, on which the sample is deposited in a layer of 5 mm thick.

- UNI-EN 300:2006 Oriented Strand Boards (OSB) - Definitions, classification and specifications

- UNE-EN 324-1:1994 Wood-based panels. Determination of dimensions of boards. Part 1: Determination of thickness, width and length.
- UNE-EN 324-2:1994 Wood-based panels. Determination of dimensions of boards. Part 2: Determination of squareness and edge straightness.
- UNE-EN 322:1994 Wood-based panels. Determination of moisture content.
- UNE-EN 323:1994 Wood-based panels. Determination of density.
- UNE-EN 120:1994 Wood-based panels. Determination of formaldehyde content. Extraction method called the perforator method.
- UNE-EN ISO 717-1:2013 Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation.