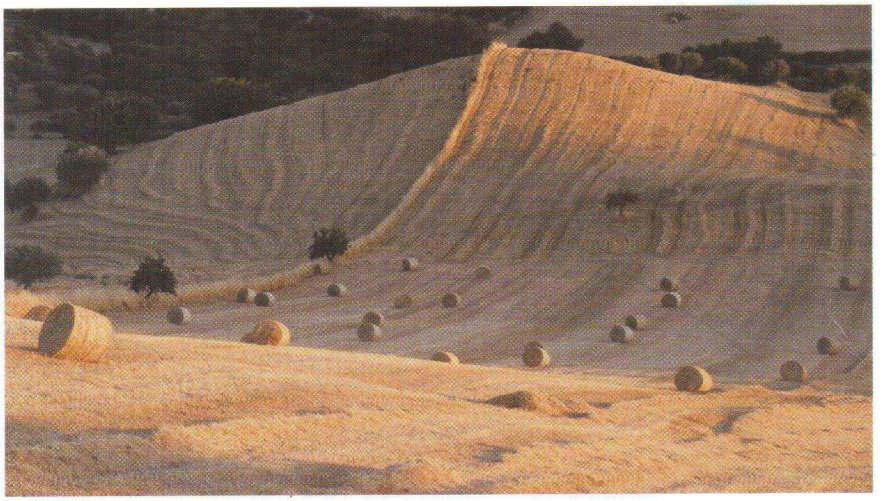
Under the President of the Italian Republic Auspices

International Conference

"Work Safety and Risk Prevention in Agro-food and Forest Systems"

RAGUSA SHWA 2010

Book of Abstracts



Hybla Campus of Ragusa - Italy
September 16-18, 2010

ElleDue Editore
Ragusa

www.ragusashwa.it

The Production and Management of Powders Obtained During the Wood Working

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Abstract
The production and the management of the residual from the milling is often object of several research in order to evaluate the opportunity of re-use them. This study has the objective to estimate the residual products at the end of the working cycle, to understand how the powders, sawdust, and wood shavings are recovered, to analyze the several their destinations and to show the system reducing their concentrations in job atmospheres.
The trials has been carried out in G R Systems. In order to find the final refuse cubature, we collected the length of the elements, because the section remained unchanged in income and in escape, as only one dimensional variable changing of the wood elements. The results demonstrated that the greater incidence of the refuse is had in the phase of planing, during which are concentrated nearly 80% of the sawdust as refuse. This product, stored in silos, comes partially destined like fuel in the company for the system of combustion of medium dimensions, about 450.000 Kcal/h, and partially for the production of pellet in an other company with productive capacity of 345 kg/h of pellets. With regard to the powder production has been clear that the drainage of the sawdust and the reintroduction in circle for a new pressing has been the critical steps because the system of aspiration does not succeed to capture all the powders. In that steps the mainly powders is raised in air and easily inhaleted as such as it is advised the use of facial filtering.

Keywords: powders, wood, residual, milling

Introduction
Actually is asserting the knowledge that the atmosphere is a planetary good and that therefore its safeguard demands participations on scale are premises that total, with immediate provisions and in the long term (Hasselmann *et al.*, 2003). On this logic a strong cultural interest regarding the production is based and consequent use of biomasses deriving from agricultural and forest field that has realized in policies and technologies times to the recovery of the refuse to the energetic aims contributing to the performance of the protocol of Kyoto. So, today it is not spoken more than refusal than a working or of a production process but of residual; if then the production process regards the primary industry of milling, politics of the biomasses concur to the development of strategies that increasing their productivity in forestry sector. In particular in some type of lumber workings, the produced refuse are partially a completely usable material to fine energetic and also powders of hard wood now recognized as cancerogenous for human health. The dangerousness of such thus fine materials by now is for a long time assessed, being emerged a direct correlation cause and effect between exposure to wood powders and carcinoma of the nose. The relation between the exposure to wood powders and the insorgence of adenocarcinoma very clearly appear or like association or in the result of some studies case-control (Cirla et al., 2008). It is particularly

obvious in the industries of the furniture fabrication, while absent for forestry workers (IARC, SCOEL). So, our study has the objective to characterize and to determine the productivity experimentally, in terms of residual of wood and powders, of a system for the production of lamellar wood for uses buildings during each step of the production process and to assume the reuse of the residual products.

Materials and methods

The experimental trials were done to characterize and to determine the productivity experimentally, of residual of wood and powders during each steps in the G R Sistemi Holzindustrie Company, in Tito, in an area of great industrial expansion next to Potenza. In this company it is produced, mainly, lamellar wood for uses buildings and several types of panels for the building to action carrying and elevated thermal insulation; such product is constituted from a double layer of boards of white fir with interposed heat insulator constituted from polystyrene expanded synthetized (EPS) with equal density to 35 kg/m^3, high insulating and structural properties.

THE PRODUCTION PROCESS OF THE G.R. SYSTEMS are the following one:

- **Choise of the lumber wood** of pinewood classified on the origin depending on defined categories trades;
- **Drying stiff operation** to obtain that humidity degree of the wood compatible with the type of glue and, above all, suitable to the destination. Generally it must be between 7 and 16%;
- **Quality control of the boards.** At first the splicer works on the boards and then there's a control of the humidity and the defective state, partially automated, and eventual elimination of the more serious defects using a dedicated machine;
- **Joint of head**. Fingers or comb joints (concur to obtain a wide surface of gluing). Successively to the milling, the gluing of head of the boards is done, carried out from appropriate blots some that apply variable forces of jam in relation to the length of the teeth of the joints;
- **Planing and gauging of the boards**. It concurs to obtain superficial smooth, requirement a lot important in phase of gluing;
- **Gluing of the laths**. The adhesives must establish intermolecular ties between the same glue and the substances that constitute the wood, that is the fibers of cellulose and lignin ("cables glue spreader");
- **Pressing;**
- **Planing of the beams** (to give to the elements the ended thickness and to make smooth uniforms and superficial the lateral ones);
- **Finishing and impregnation**. The beam comes registered realizing the necessary bending of plan, holes and cuts for the assemblage of metallic elements and application of products impregnating through painting, substances that is with function to protect the wood from bugs, fungi, humidity and with a pigment that confers to the beams the desired colour. Once characterized the production process, for each phase refuse kind and amounts have been estimated considering also the job carried out from the system for the recovery and the removal of powders from the job places. In particular for the esteem of the refuse amount produced in each phase card "OUTCUT" that concurs to find the quantitative ones input and to confront them with those output of every phase, so as to have an accurate numerical data of the refuse has been obtained experimentally.

Results

The trials done demonstrated that the first requirement of guarantee of the end product was the choice of the lumber: the technical characteristics of the finished product depend from the base material. It is obvious that in order to obtain turned out reliable, is necessary to leave from a raw materials being had characteristic the most homogenous and uniforms possible. The drying then has carried the product to humidity values of 13%, compatible with the glue use. Before the veneer jointing the boards quickly have a control of the humidity and the defective state, partially automated, finalized to the elimination of the boards with more serious defects. In this phase our relief is begun considering the working refuse obtained from the radial cut of the boards, in which only the variable one determine the proportions them has been the length of the elements. The refuse on approximately 20 m3 of worked wood has been equal to 0.44 m3, approximately 2.25% on the total of the raw materials worked; the type of refuse is characterized in great part from tablets of equal medium dimensions about mm 46 x 155 x 180/200. In the successive phase of veneer jointing, the cross seams currents between the several ones laths come carried out with said comb joints or fingers.

The refuse of working of the splice is obtained from the cross-sectional milling of the boards; the final cubature of the refuse is calculated considering geometry of the tool, usually a moulder that directly executes the working on the wood removing in constant way always the same amount of material.

Table 1. Veneer jointing

INPUT				
DIMENSIONI			fresa	scarto
SP	BASE	LH / mm.	impulsi	mc
0,023	0,25	0,02	402	0,04623
0,05	0,245	0,02	146	0,03577
0,046	0,15	0,02	758	0,104604
0,038	0,175	0,02	808	0,107464
TOTALI				0,294068

As shown in the table 1, the refuse has been calculated multiplying the section of the boards of wood per the number of milled (impulses) carried out from the system, considering like constant the step of the equal tool to 0.02 mm. During the planing and gauging of the boards Table 2) the composed boards have been planed in order to offer superficial flat in sight of the gluing of the faces of the boards for the next formation of the beam. This type of operation, with the gauging through which boards of constant thickness are obtained, avoids establishing itself of tensions that can give rise to the formation of checks during the pressing. Moreover the planing concurs to obtain superficial smooth, requirement a lot important in phase of gluing.

The collected refuse, in the phase of unframing, is those obtained from the planing on the four faces of the boards; for being able to find the cubature total of the refuse, they have been brought back in the calculation table the dimensional changes them of the ligneous elements in entrance and escape from the machinery. The significant dimensional change was the section, in fact like Planing can be found from the table "Gluing" (Table n.2), the difference between section in income and that in escape is about 6 mm on 15 mm thickness on the width of the board. This phase of the process, represents approximately 14% of the refuse of the raw

materials worked on the examined productive cycle. The biomass of refuse is constituted from small chip, sunder dust and powders.

Table 2. Planing – Gluing

INPUT					OUTPUT					DELTA
DIMENSIONI			N° PZ	MC.	DIMENSIONI			N° PZ	MC.	
SP	BASE	LH / ml.			SP	BASE	LH / ml.			
0,044	0,151	10	52	3,45488	0,0425	0,15	10	52	3,315	0,13988
0,023	0,215	4	114	2,25492	0,0225	0,21	4	114	2,1546	0,10032
0,0465	0,12	7,05	56	2,202984	0,046	0,115	7,05	56	2,088492	0,114492
0,0465	0,12	5,53	30	0,925722	0,046	0,115	5,53	30	0,877611	0,048111
0,046	0,175	4	40	1,288	0,043	0,17	4	40	1,1696	0,1184
0,023	0,215	4	40	0,7912	0,0225	0,21	4	40	0,756	0,0352
0,046	0,15	11,4	18	1,41588	0,0315	0,135	11,4	18	0,872613	0,543267
0,023	0,215	4	72	1,42416	0,0225	0,21	4	72	1,3608	0,06336
0,023	0,215	4,7	60	1,39449	0,0225	0,21	4,7	60	1,33245	0,06204
0,023	0,215	4,7	24	0,557796	0,0225	0,21	4,7	24	0,53298	0,024816
0,023	0,215	4	4	0,07912	0,0225	0,21	4	4	0,0756	0,00352
0,046	0,245	6	46	3,11052	0,043	0,24	6	46	2,84832	0,2622
0,038	0,175	11,3	14	1,05203	0,031	0,17	11,3	14	0,833714	0,218316
0,038	0,175	11,3	14	1,05203	0,031	0,17	11,3	14	0,833714	0,218316
0,05	0,245	6	40	2,94	0,043	0,24	6	40	2,4768	0,4632
0,023	0,215	4	100	1,978	0,0225	0,21	4	100	1,89	0,088
0,023	0,215	4	72	1,42416	0,0225	0,21	4	72	1,3608	0,06336
0,023	0,215	4	148	2,92744	0,0225	0,21	4	148	2,7972	0,13024
0,023	0,215	4	212	4,19336	0,0225	0,21	4	212	4,0068	0,18656
0,023	0,215	4	72	1,42416	0,0225	0,21	4	72	1,3608	0,06336
0,023	0,215	4	70	1,3846	0,0225	0,21	4	70	1,323	0,0616
0,023	0,215	4	58	1,14724	0,0225	0,21	4	58	1,0962	0,05104
0,046	0,245	4	44	1,98352	0,043	0,24	4	44	1,81632	0,1672
0,038	0,22	2,4	24	0,481536	0,034	0,215	2,4	24	0,421056	0,06048
0,038	0,22	3	14	0,35112	0,0335	0,215	3	14	0,302505	0,048615
0,038	0,22	3,2	20	0,53504	0,0325	0,215	3,2	20	0,4472	0,08784
0,023	0,215	4	20	0,3956	0,018	0,19	4	20	0,2736	0,122
0,023	0,215	4	44	0,87032	0,018	0,19	4	44	0,60192	0,2684
0,023	0,215	4	80	1,5824	0,018	0,19	4	80	1,0944	0,488
0,023	0,215	4	70	1,3846	0,018	0,19	4	70	0,9576	0,427
0,023	0,215	4	70	1,3846	0,018	0,19	4	70	0,9576	0,427
0,023	0,215	4	70	1,3846	0,018	0,19	4	70	0,9576	0,427
0,023	0,215	4	70	1,3846	0,018	0,19	4	70	0,9576	0,427
0,023	0,215	4	70	1,3846	0,018	0,19	4	70	0,9576	0,427
0,023	0,215	4	70	1,3846	0,018	0,19	4	70	0,9576	0,427
0,023	0,215	4	100	1,978	0,018	0,19	4	100	1,368	0,61
TOTALI				54,90783					47,4337	7,474133

The next phase of refuse production is the planing of the beams, where the produced refuse is that one obtained from the material removal on the four faces of the beam. By the research we checked the dimensional changes of the ligneous elements in entrance and escape from the machinery. The dimensional change taken in account was the section, in fact as shown in table n 3 during that phase of the process there was the production of approximately 18% of the refuse of the raw materials worked on the examined productive cycle. The biomass of refuse is constituted from small chip, powders and sunder dust.

The refuse of the final working is variable according to the type of shape, cut or milling to carry out, following technical specification of the graphical elaborated ones. In the table 4 and 5 "Working - simple" and "Working - Capitello" can be found the refuse differences between two wrappings standard taken to champion. The biomass of refuse is introduced under form of solid wood of crude fir with volumic mass about 450 Kg /Mc.

Table 3. Planing – Finishing

INPUT					OUTPUT					DELTA
DIMENSIONI			N° PZ	MC.	DIMENSIONI			N° PZ	MC.	
SP	BASE	LH / ml.			SP	BASE	LH / ml.			
0,046	0,245	4	44	1,98352	0,043	0,24	4	44	1,81632	0,1672
0,0425	0,075	10	28	0,8925	0,039	0,06	10	28	0,6552	0,2373
0,0225	0,21	4	114	2,1546	0,02	0,19	4	114	1,7328	0,4218
0,046	0,115	7,05	56	2,088492	0,032	0,098	7,05	56	1,238093	0,850399
0,046	0,115	5,53	30	0,877611	0,032	0,098	5,53	30	0,520262	0,357349
0,043	0,17	4	40	1,1696	0,042	0,15	4	40	1,008	0,1616
0,0225	0,21	4	40	0,756	0,02	0,19	4	40	0,608	0,148
0,0225	0,21	4	72	1,3608	0,02	0,19	4	72	1,0944	0,2664
0,0225	0,21	4,7	60	1,33245	0,02	0,19	4,7	60	1,0716	0,26085
0,0225	0,21	4,7	24	0,53298	0,02	0,19	4,7	24	0,42864	0,10434
0,0225	0,21	4	4	0,0756	0,02	0,19	4	4	0,0608	0,0148
0,043	0,24	6	46	2,84832	0,04	0,22	6	46	2,4288	0,41952
0,043	0,24	6	40	2,4768	0,04	0,22	6	40	2,112	0,3648
0,0225	0,21	4	100	1,89	0,02	0,19	4	100	1,52	0,37
0,0225	0,21	4	72	1,3608	0,02	0,19	4	72	1,0944	0,2664
0,0225	0,21	4	148	2,7972	0,02	0,19	4	148	2,2496	0,5476
0,0225	0,21	4	212	4,0068	0,02	0,19	4	212	3,2224	0,7844
0,0225	0,21	4	72	1,3608	0,02	0,19	4	72	1,0944	0,2664
0,0225	0,21	4	70	1,323	0,02	0,19	4	70	1,064	0,259
0,0225	0,21	4	58	1,0962	0,02	0,19	4	58	0,8816	0,2146
0,043	0,24	4	44	1,81632	0,04	0,22	4	44	1,5488	0,26752
0,02	0,21	4	20	0,336	0,018	0,19	4	20	0,2736	0,0624
0,02	0,21	4	44	0,7392	0,018	0,19	4	44	0,60192	0,13728
0,02	0,21	4	80	1,344	0,018	0,19	4	80	1,0944	0,2496
0,02	0,21	4	70	1,176	0,018	0,19	4	70	0,9576	0,2184
0,02	0,21	4	70	1,176	0,018	0,19	4	70	0,9576	0,2184
0,02	0,21	4	70	1,176	0,018	0,19	4	70	0,9576	0,2184
0,02	0,21	4	70	1,176	0,018	0,19	4	70	0,9576	0,2184
0,02	0,21	4	70	1,176	0,018	0,19	4	70	0,9576	0,2184
0,02	0,21	4	70	1,176	0,018	0,19	4	70	0,9576	0,2184
0,02	0,21	4	100	1,68	0,018	0,19	4	100	1,368	0,312
TOTALI				45,35559					36,53364	**8,821958**

Table 4. Primary manufacturing

INPUT					OUTPUT					DELTA
DIMENSIONI			N° PZ	MC.	DIMENSIONI			N° PZ	MC.	
SP	BASE	LH / ml.			SP	BASE	LH / ml.			
0,032	0,098	5,53	30	0,520262	0,032	0,098	5,5	30	0,51744	0,002822
0,0315	0,135	11,4	18	0,872613	0,0315	0,135	11,38	18	0,871082	0,001531
0,1	0,2	2,71	5	0,271	0,1	0,2	2,7	5	0,27	0,001
0,1	0,2	2,7	4	0,216	0,1	0,2	2,54	4	0,2032	0,0128
0,1	0,2	2,54	4	0,2032	0,1	0,2	2,38	4	0,1904	0,0128
0,1	0,16	2,57	1	0,04112	0,1	0,16	2,51	1	0,04016	0,00096
0,1	0,16	2,57	1	0,04112	0,1	0,16	2,54	1	0,04064	0,00048
0,1	0,16	2,51	1	0,04016	0,1	0,16	2,35	1	0,0376	0,00256
0,1	0,16	4,58	1	0,07328	0,1	0,16	4,55	1	0,0728	0,00048
0,035	0,165	4	1	0,0231	0,035	0,165	3,15	1	0,018191	0,004909
0,023	0,21	4	23	0,44436	0,023	0,21	3,52	23	0,391037	0,053323
0,07	0,24	4,03	18	1,218672	0,07	0,24	3,9	18	1,17936	0,039312
0,16	0,24	6,62	24	6,100992	0,16	0,24	6,59	24	6,073344	0,027648
TOTALI				10,06588					9,905254	**0,160625**

In the table 6 has been reported the amount of residual, the type and the use

Tabella 5. Manifacturing - Capitello

INPUT					OUTPUT				DELTA
DIMENSIONI			N° PZ	MC.	DIMENSIONI		N° PZ	MC.	
H	BASE	LH / ml.			SUP. (HxLH)	BASE			
0,15	0,08	2,7	12	0,3888	0,3898	0,08	12	0,374208	0,014592
0,15	0,08	3,75	2	0,09	0,5473	0,08	2	0,087568	0,002432
0,2	0,12	3,03	1	0,07272	0,583	0,12	1	0,06996	0,00276
0,12	0,08	1,77	5	0,08496	0,204	0,08	5	0,0816	0,00336
TOTALI				0,63648				0,613336	0,023144

Tabella 6. Amount, type and reuse of residual

Work done	**Type of refuse**	***Amount Mc.**	**** % refuse**	**Storage**
Optimization	Solid 	0,44	6,30	Grinding/ silos
Veneer jointing	Sawdust 	0,30	3,40	Silos
Planing – Gluing	Sawdust 	7,50	39,50	Silos
Planing – Finishing.	Sawdust 	8,82	50,80	Silos
Processing	Solid 	Variable	Variable	Container

* With regard to each sample examined per operation.
** % of total refuse amount.

For how much it concerns the powder production during the working cycle and their management, relatively to the operations of milling, planing and gauging of the boards it used to inhale them from a closed loop system with evacuation and filtering of the exhausted air (system to localized aspiration); in fact, all the equipment are connected to a system of rigid and flexible pipages which directed the sawdust and the powders inhaled in the two silos of collection, with total capacity of 160 m^3, placed outside of the working structure (Figures n.1 and 2); the stored sawdust was characterized by a humidity comprised between the 8 and 12%.

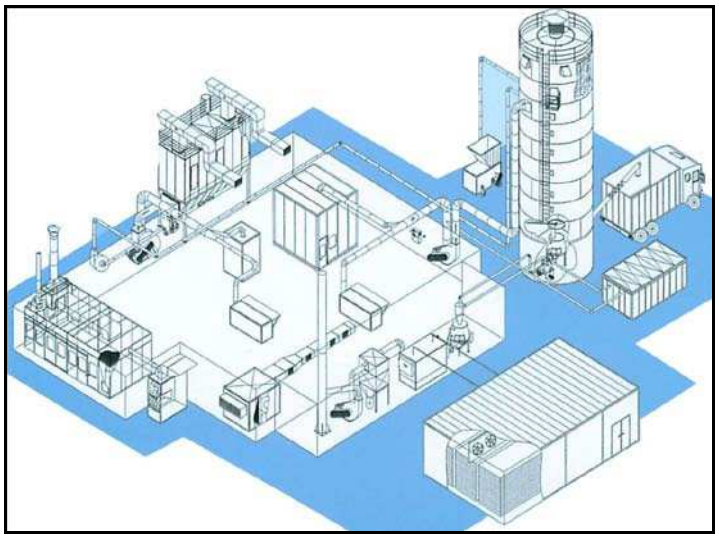

Figure 1. Design of working cycle

Figure 2. Particular of system of dust suction

Conclusions

The experimentation done has confirmed of the guidelines generalized in the industry of the working of the wood. Normally the refuse comes reused inside of the company for the heating of the premises and in the production process. The wood refuse has also a market, and the companies complete the choice between the various destinations on the base of variables as the energetic internal necessities of the company, the abilities to investment in technologies

for re-use, the conditions of market of the refuse and it law obligation. This at least partially explains the high variability of the relative data to the energetic employment. After all the quantitative ones of wood material recovered every year from the industries of the field wood - furnishing is remarkable: approximately 5,6 million residual tons of coming from first and the second milling which are reused as raw materials or fuel in order to produce energy or heat. The use of these residual ones as raw materials so diffused that, in order to satisfy the request of the companies, every year the imports pile to beyond 1,2 million tons. The economic value of these huge quantitative ones of WOOD TO RECYCLE is gone currently around 175 million euro per year, without to forget that the development of the differentiated collection sure will carry to an increase of the turnover (Source: Federlegno-Furnishings elaborations).
Regarding the powder emission, the presence of a system to aspiration localized with a system of cartridge filtering is to high effectiveness and efficiency. However, even if it comes used a system of localized aspiration, in spite of the considerable inferior concentration of powders in the air or to the value limit equal to 5 mg/m^3 from the D.Lgs. 81/08, remain however a lowest potentially injurious powder concentration; for which in order increasing to the effectiveness of the systems the workers they would have to use the personal protective apparatus them as, for example, during the operation of manual smoothing. Anyway, the risk for the workers to accuse disturbances to the health, because of the powder inhalation, diminishes drastically in the factories in which the systems to localized aspiration are present. Our study follows to conclude that the system examined can represent a valid example of management optimized of the residual ones of milling, with suitable technologies adapted and to the materials, systems to norm and above all safeguard of the sanitary conditions of the places of job and the workers.

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Each author contributed in that paper in the same measure.