



## Defining Formaldehyde concentration emission from wood manufactured from pruning

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**Abstract:** Boards of wood was manufactured from pruning (*alhagi maurorum* l, *prosopis stephaniana*, common reed , pine , apple and *Gossypium* sp ) , using urea- formaldehyde in percent of 12% as adhesive. Formaldehyde emission from those boards was defined by flask method after 24 hours by using spectrophotometer at extreme wavelength 412 nano meter .Exhausting ratio of all manufactured boards was under Europe norm ( 5 mg /100 dry weight ), the highest ratio was ( 4.04 mg/ 100 dry weight ) in *alhagi maurorum* l , the lowest one was (2.34 mg/ 100 dry weight) in *prosopis stephaniana*, while it was converging in common reed, pine, apple and *Gossypium* sp ( 3.73 ,3.39, 3.01, 3.29 mg/100 dry weight) consecutively. Therefore, boards of wood manufactured by pruning residues could be used to manufacture furniture and desks instead of throw it without getting environmental benefit as it is healthy.

**Keywords:** Formaldehyde emission, Boards of wood, pruning.

### Introduction :

Nowadays, world witnesses constant increasing in produced and consumptive amounts of manufactured wood , especially compressed wood( particle board) and fiber wood of average thickness(Medium Density Fiber board , MDF) . Whereas international production of compressed wood reaches into 79868000 m<sup>3</sup> in 2003. This considerable increasing was accomplished with doing researches worldwide aims to put norms of technical characters and health standards for using manufactured wood indoors. Exhausting Formaldehyde from wood problem, which is a common problem in Europe and Scandinavia for more than 25 years, was the first norm to discussed [18] .

The main source of Formaldehyde is the gluey materials used in wood manufacturing such as : urea-formaldehyde , phenol form aldehyde , melamine –urea phenol form aldehyde. In 1992, the California Air Resources Board [4] identified formaldehyde as a toxic air contaminant based primarily on the determination that it was a human carcinogen with no known safe level of exposure. The International Agency for Research on Cancer [29]conducted an evaluation of formaldehyde and concluded that there is sufficient evidence that formaldehyde causes nasopharyngeal cancer in humans (*i.e.*, in the region of the throat behind the nose). Formaldehyde is a well known allergen that causes contact dermatitis. Formaldehyde can be free on the material or bonded in different ways to the chemical structure. Free formaldehyde, including bonded formaldehyde, can be released under different analytical conditions[28] .

In 2008, Hutter and his colleagues mentioned that exposing to formaldehyde for 30 min at concentration of 0.10 mg / m<sup>3</sup> causes polypnea[27] . While exposing to formaldehyde for 24 hours at concentration of 0.06 mg /m<sup>3</sup> causes inflammation in the upper part of human body [41]. Therefore, higher

department of testing harmful Material in Germany classified formaldehyde in B-III group which contains materials that cause cancers [19,43].

In addition of considerable harm incentral nerve system caused by increasing concentration of formaldehyde above (0.1 mg/L) in breathe air [3]. Formaldehyde exhausts from furniture manufactured of compressed wood and fiber wood, especially in winter while temperatures raise in houses, which causes cancers and eyes inflammation .

The allowed limit of formaldehyde exhausting from manufactured wooden material is different between a country and another. It is (1 mg/L) in Germany, Denmark, Poland and Yugoslavia , (2 mg/L) in Britain, Netherlands and Sweden, (1-2mg/L) in USA and Australia , and (1.5mg/L ) in Italy Howlett [26], Roffael [43,44] and Wittmann [47] studied formaldehyde exhausting from compressed wood in Germany, while Allan [1] studied how to produce formaldehyde from Urea- formaldehyde (UF)[46].

Aminoplastic resins, especially UF-resins, are the main binders used in the industry of wood-based panels. UF-resins are fast curing resins and of uncontested good performance. However, boards bonded with UF-resins are, in general, of limited moisture resistance and emit detectable amounts of formaldehyde [45] . Furthermore, concern about the emission of formaldehyde from particleboards and weakening glue bond caused by hydrolytic degradation of UF polymers have stimulated efforts to develop improved and/or new adhesives based on UF resins. [9].

Andrews [2]and Cherubim [5] study formaldehyde emission (FE) test ways.Roffael[42] estimated formaldehyde from compressed wood, manufactured by phenol formaldehyde , by using different ways and compared it with flask way (WKI)[46] . Recently, continuous methods have also been proposed for assessing the formaldehyde release during production in the factories [10, 11] . In Europe, mainly three laboratory methods for the determination of formaldehyde release have been standardized and namely: 1) Extraction method called the perforator method [12], 2 FE by gas analysis method [16] and 3, FE by the flask method [17], [13- 14,20-25] .

This study aims to estimate formaldehyde emission from wood manufactured with result from Prune:(*alhagi maurorum l*, *Gossypium sp* , common reed , pine , apple and *Prosopis stephaniana* ) by German flask WKI (Wilhelm – Klauditz – Institut) certified by European norm EN-717-3[17] , and compare it with standard formaldehyde exhausting from compressed wood and average density fiber wood according to European Norms [7].

## Materials and Methods

### Samples :

Results of Prune: *alhagi maurorum l*, *Gossypium sp* , common reed , pine , apple and *Prosopis stephaniana* .

### Chemical materials :

Acetyl acetone 99% , ammonium acetate 98%, urea- formaldehyde 98%, and aluminum sulfate 98% (Merck) , poly ethylene flasks 500ml with tight cover equipped with a metalhook .

### Instrumentation:

Spectrophotometer with maximal wavelength absorption (412) nano meter. ( Jenway, 6300)

### Methods:

#### 1- Compressed wood boards manufactured by residues of pruning :

Boards of compressed wood has been manufactured according to the approved method of Dutch industry norm [7] , which used in research centers in Europe , to exam the ability of using raw wood for manufacturing compressed wood according to manufacturing conditions applied in Dutch and Europe factories.

The steps were : 15 kg of Sawdust of alhagi maurorum l, Gossypium sp , common reed, pine , apple and *Prosopis stephaniana* pruning has been dried in hot air drying machine at 40 C<sup>0</sup> for 24 hours and 5% humidity. After that , the glue has been prepared in a glue mixer by melt thermal glue powder Urea formaldehyde ( 12% of dry sawdust) , then added solufate ammonium to harden the glue ( 2% of dry material in the glue ). Sawdust was glued in a mixer that has spraying gun with filled vessel of glue , glued sawdust was put in a wooden frame (45cm x 45cm dimension and 30cm depth ) on a metal salver ( 45cm x45cm ).

After that wooden cover ( 42.75 cm x42 .75 cm ) was put on the glued sawdust , sawdust was pressed by stepping on , then the wooden frame was pulled to get a pallet of sawdust , then it was put under a metal salver ( 45 cm x 45 cm) in which the sawdust became stranded between two salvers. The two slavers was entered between slabs of thermal compressor at 190 C<sup>0</sup> for 8 min to 18mm thickness under 30 kg/cm<sup>2</sup> of industrial pressure after putting metal bars (18 cm thickness) to define thickness. Finally, the manufactured board was cooled and it edges was defined by disc saw to be 41cm x 41cm dimension.

## 2- Estimate exhausting of form aldehyde from manufactured patterns according to flask method WKI Wilhelm-Klauditz-Institut : authorized as a Europe norm EN: 717-3 [7,17,44].

During a few hours before the exam , pieces of 25mm ( thickness of board from the compressed board ) are sawed , two pieces or three (15-20 g ) are put after exact weight of 0.001 g , then they are linked by crossed two elastic rings and attached with the crook of the flask at cross point.After that, 50 ml of distilled water are added in poly ethylene flask (500ml), the sample is entered carefully to the flask so that it rises 4cm at least of surface of distilled water then closes the flask tightly. Flask is put in aerial dryer regulated on 40C<sup>0</sup> according to test period (24h) accomplished with witness sample (50ml distilled water in a flask without wooden sample inside it ). It must be noted that flasks should not take more than 10% of dryer mass and 5cm separates between them. The flask is put out for 1 hour in 20 C<sup>0</sup> till it becomes cold. This test is done for each wooden kinds in two flasks WKI, after that deteriorated formaldehyde concentration in distilled water is estimated by spectrophotometer as following :

10 ml of resolution contains formaldehyde existed in each flask (including witness flask) is taken to be put in 50ml bottle (two of 50ml bottles for each WKI flask), then 10 ml of ammonium acetate resolution 20% and 10ml of ace tale acetone 0.04M added , bottles and witness sample are closed and put in shaking wet dock in 40 C<sup>0</sup> for 15 min , bottles taken out of the dock to put in a drawer for an hour in room temperature 20 C<sup>0</sup> to become cold without being exposed for light. Resolution becomes yellowish green according to formaldehyde concentration in the solution, concentration is determined by spectrophotometer opposite to distilled water in wavelength 412 nanometer. Finally formaldehyde concentration which exhausted in mg for each 100 g of dry weight (mg/100g) according to :

$$Y = \frac{(a - b) * f * 5 * 100}{1000 * m}$$

Where :

a: sample absorbtion at wavelength 412 nanometer .

b : blank absorbtion at wavelength 412 nanometer .

f: factor

m: dry sample weight .

## Results and discussion:

The reaction of urea with formaldehyde first produces hydroxylmethyolated urea that then condenses to yield methylene and dimethylene ether bridged urea polymers [35, 39]. These reactions are use to produce the formaldehyde-containing wood adhesives, the UF polymers were distinct as they are susceptible to hydrolysis under some normal conditions used [37].

The formaldehyde amount in the water from the method above was determined photometrically by acetylacetone spectrophotometric analysis. This technique, as described by Nash [38], is widely applied and is a standard procedure for the specific analysis of free formaldehyde. The determination is based on the Hantzsch reaction, in which aqueous formaldehyde reacts with ammonium ions and acetylacetone to yield diacetylhydrolutidine (DDL). The amount of free formaldehyde observed in the chamber under conditions

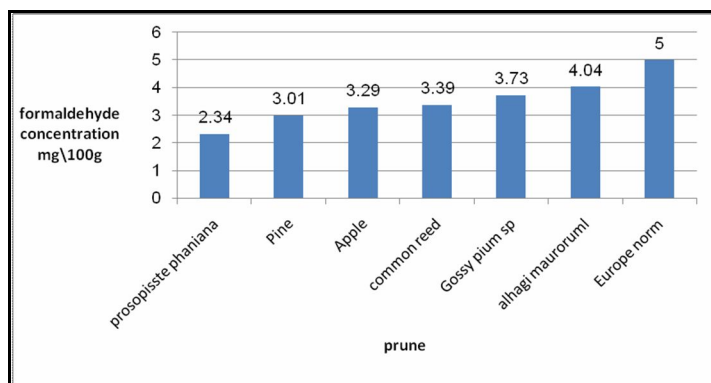
that simulated mobile loadings of wood product, air change rate, temperature, and humidity relate to real wood formaldehyde levels [36,40].

Table (1) and figure (1) show: formaldehyde concentration emission from wood boards manufactured of pruning residues with using urea-formaldehyde in percent of 12%. The highest ratio was ( 4.04 mg/ 100 dry weight ) in *alhagi maurorum l* , the lowest one was (2.34 mg/ 100 dry weight) in *prosopis stephaniana* , while it was converging in common reed , pine , apple and Gossypium sp ( 3.73 ,3.39, 3.01 , 3.29 mg/100 dry weight ) consecutively. However , formaldehyde exhausting values were under Europe standards [7] (5 mg/100 dry weight ) after 24 hours , in order to use urea-formaldehyde which reduce exhausting of formaldehyde as it represent a contracting matter for formaldehyde .[6,8,30,31,44] . Differentiation of exhausting ratio and lack of it among studied species may be related to primary and secondary extracts ratio for pruning residues which represent a contracting matter for formaldehyde [32-34] and by wood product [3,40] . Dropping formaldehyde values under Europe standards in boards of wood manufactured by pruning residues means that they could be used to manufacture furniture and desks instead of throw or burn it without getting environmental benefit as it is save for health and environment .

**Table 1: Formaldehyde concentration from wood manufactured from pruning**

form aldehyde concentration (mg /100 g dry weight)	Prune of tree
4.04 ± 0.10*	<i>Alh agimauroruml</i>
3.73 ± 0.11	Gossypiumsp
3.39 ± 0.10	Common reed
3.01 ± 0.12	Pine
3.29 ± 0.12	Apple
2.34 ± 0.19	<i>Proso pisstephaniana</i>
5	Europe norm

\*Values are the means of three replicates



**Figure 1: Formaldehyde concentration from wood manufactured from pruning**

## Conclusion :

Results showed that formaldehyde ratio emission from wood boards manufactured from pruning residues is under Europe norms. Therefore it considers save and healthy and could be used to manufacture furniture and desks.

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