

CONVECTIVE DRYING OF WOOD CHIPS AT HIGH TEMPERATURE

Summary

Drying of wood chips of the average size 15x5x2 mm and the initial moisture content 50% w.b. was experimentally studied. The drying medium was hot air at the inlet temperature of 500°C, that is well above the ignition temperature of dry wood (approx. 300°C). The experiments were carried out in an electrically heated stove equipped with a device to mix and move wood chips samples. No significant change in the surface colour of wood chips was observed. Drawing conclusions from the experimental result, industrial – scale drying of wood chips in a rotary dryers or similar ones at 500°C inlet temperature of drying air can be envisaged.

Introduction

The present work was performed in order to evaluate the feasibility of drying wood chips in a drum dryer operated at 500°C inlet temperature of the drying gas. As the ignition temperature of dry wood is approximately 300°C, experiments were made to find out whether or not the gas inlet temperature poses the risk of wood chips catching fire. The following operating parameters of an industrial-scale dryer were taken as a starting point:

inlet capacity of wet material	7270 kg/h
inlet moisture content	50 kg H ₂ O/kg, 50 [%]
outlet moisture content	9,1 kg H ₂ O /kg, 9,1 [%]
water evaporation	3 270 kg/h
inlet temperature of drying gas	approx. 500°C
outlet temperature of drying gas	approx. 105°C
sizes of wood chips:	
- length	up to 15 mm
- width	up to 5 mm
- thickness	up to 2 mm
bulk density	approx. 250 kg/m ³ .

Materials, methods and results

The drying of wood chips at high temperature was experimentally simulated by placing the material in an electrically heated stove. The size of the chamber available for experiments was: 120x170x370 mm (Fig. 1).

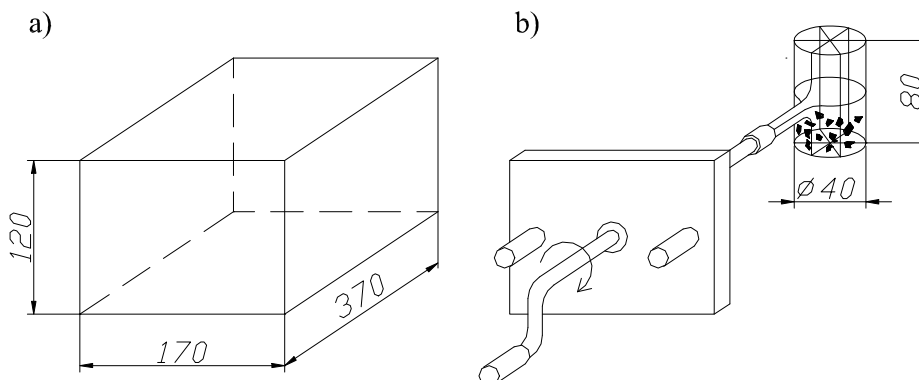


Fig. 1. Experimental setup, a) chamber sizes, b) chamber door and basket with wood chips

The stove was equipped with temperature controls making it possible to set drying conditions similar to those in the industrial apparatus. The wood chips were mixed by rotating the basket. The first series of experiments was aimed at simulating the drying conditions in the inlet part of the dryer where wet wood chips are contacted with hot air. Each experiment was carried out after heating up the chamber to 500°C. Wood chips at the initial moisture content of 50% w.b. and temperature of 18°C were placed in the basket and inserted into the chamber for a specific period of time. After that, the sample was removed from the dryer and the surface temperature of wood chips was measured using a distant-reading pyrometer. Finally, the moisture content of the sample was determined.

In the consecutive experiments, the sample was kept inside the hot chamber for 10, 15, 30, 45, 60 and 75 seconds. The results of measurements are plotted against time in Fig. 2.

In a typical experiment started at 500°C inside the chamber and lasting for 75 seconds, the surface temperature of wood chips was increased to 210°C. The air temperature in the chamber dropped to 270°C, which is well below the ignition temperature of dry wood.

Eight series of experiments were carried out at lower initial values of the temperature and lower values of the initial moisture content in wood-chip samples. The results obtained from two series of experiments are visualized in Fig. 3 and Fig. 4.

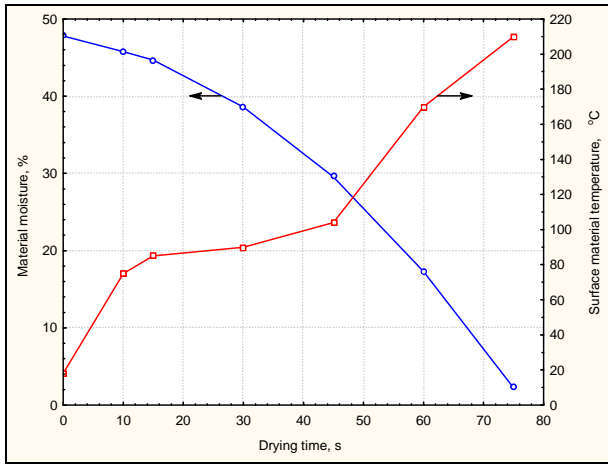


Fig. 2. Drying curve and surface material temperature at the initial chamber temperature of 500°C

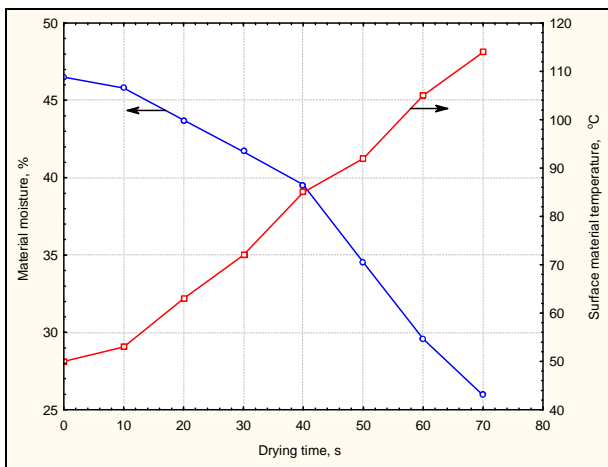


Fig. 3. Drying curve and surface material temperature at the initial chamber temperature of 420°C

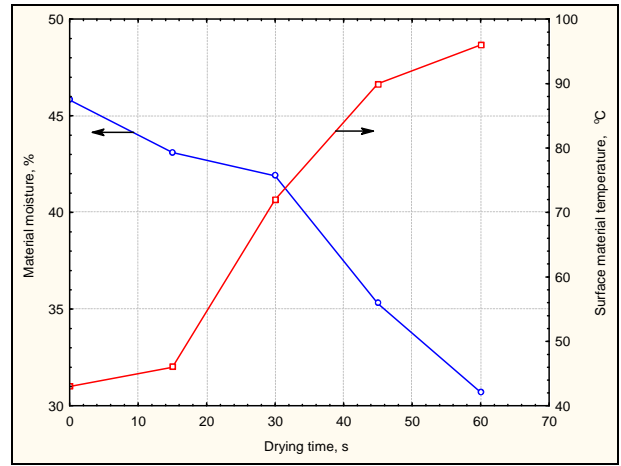


Fig. 4. Drying curve and surface material temperature at the initial chamber temperature of 380°C

As the initial temperature was reduced, the drying rate was reduced too. No change in the colour of wood chips was observed.

By combining the results of experiments with the mass balance of the industrial dryer, it can be calculated that the main part of wood-chip moisture is evaporated along the initial 3 meters length of the inlet part of the dryer. The total length of the dryer can be estimated at 11 meters.

Conclusions

The experiments indicated the possibility of drying wet wood chips at a relatively high temperature of drying air, that is, 500°C. The risk for material ignition can be avoided when the wood chips are mixed and a continuous material flow is ensured.

References

- [1] Kneule F. 1970. Suszenie. Arkady, Warszawa
- [2] Mokrzycki E. et al. Podstawy gospodarki surowcami energetycznymi. Wydawnictwo AGH, Kraków 2005.