# TECHNICAL UNIVERSITY OF ŁÓDŹ

## Department of Heat Technology and Refrigeration

# *LIGNINOCELLULOSE BIOMASS TORREFACTION USING THERMOGRAVIMETRIC METHOD COMBINED WITH FTIR ANALYSIS*

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### INTRODUCTION

Biomass has the biggest potential from all kind of renewable energy sources in Poland. Increasing the biomass share in conventional coal-power plants is an very effective and fast in implementation way of reducing a carbon dioxide and other pollutant gases emission. To increases the biomass share up to 30 or even 40% thermal, the biomass particles must be milled down to sizes where caloric values can be expected. There are many different biomass pre-treatment methods which can be use to convert biomass into more coal-like matter. Such as process like torrefaction should be more deeply investigate to get a briefly overview on this kind of biomass thermal conversion technique.

### TORREFACTION PROCESS PRINCIPLE

Torrrefaction is a thermal treatment technique that occurs in a inert atmosphere. Carbonization or torrefaction is a thermal degradation of biomass structures by heating it without air contact under atmospheric pressure. It removes low weight organic volatile components and moisture as well as depolymerises the long polysaccharide chains of biomass. This kind of process of wood carbonization is quite complex research subject due to the fact that wood contains different fractions. When we look in microscopic scale, wood cells are build from microfibrils, bundles of cellulose molecules 'coated' with hemicellulose. Another component of wood biomass is lignin which is deposited between microfibrils and in some types of biomass in the amorphous regions of the microfibril. All of those three fractions represents different thermal behavior. As a torrefaction product we get a hydrophobic solid fuel with greatly increased grindability and energy density (on a mass basis). What is more important we lower requires energy to process the torrefied biomass and it not longer requires additional separate handling facilities when we co-combusted new fuel with coal in operating power plants. It is suggested that torrified biomass can be compacted into high grade pellets with substantial superior fuel properties compared with standard wood pellets from un-treated biomass.

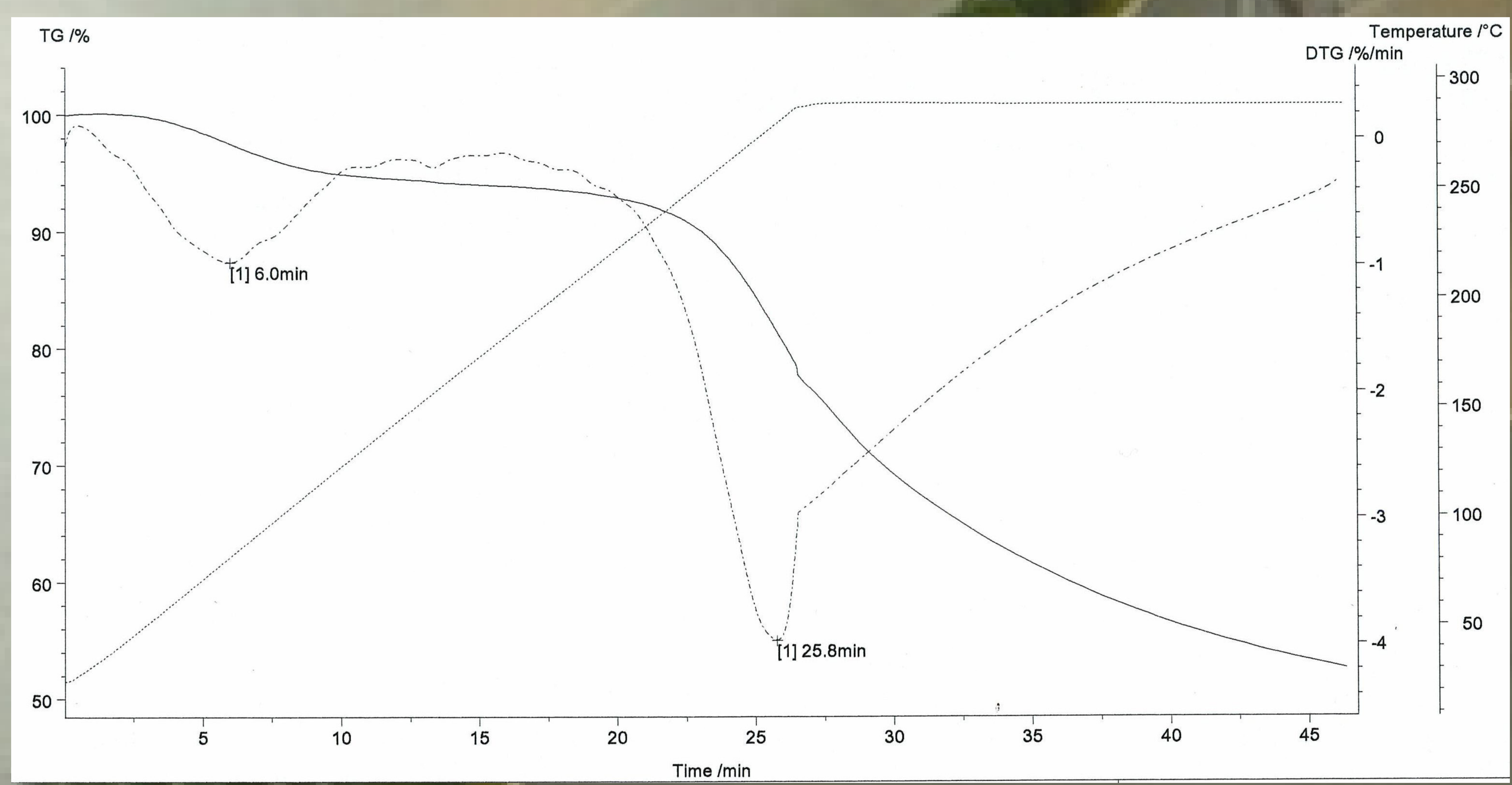


**Fig. 1. Thermal Analysis of millet with Cd under isothermal conditions**

Composition of biomass determines its behavior during carbonization process. In my research I have chosen five different types of wooden biomass: millet, reed, willow, jerusalem artichokes and mallow. All of those five types are coming from central part of Poland (province of łódz) and were pre-dry to obtain moisture content in the range of 5-10%.

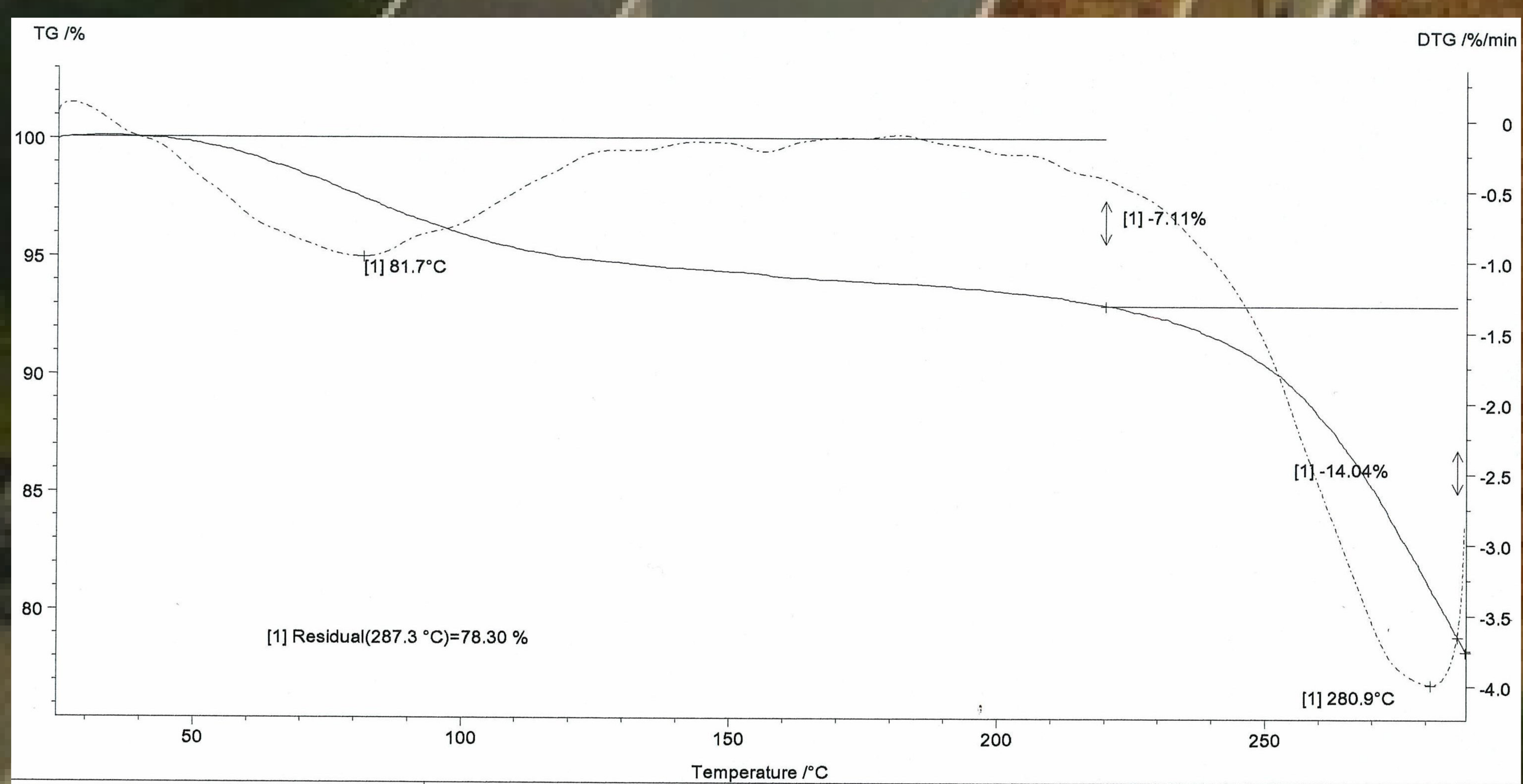


**Fig. 2. Thermal Analysis of millet with Cd under isothermal conditions**

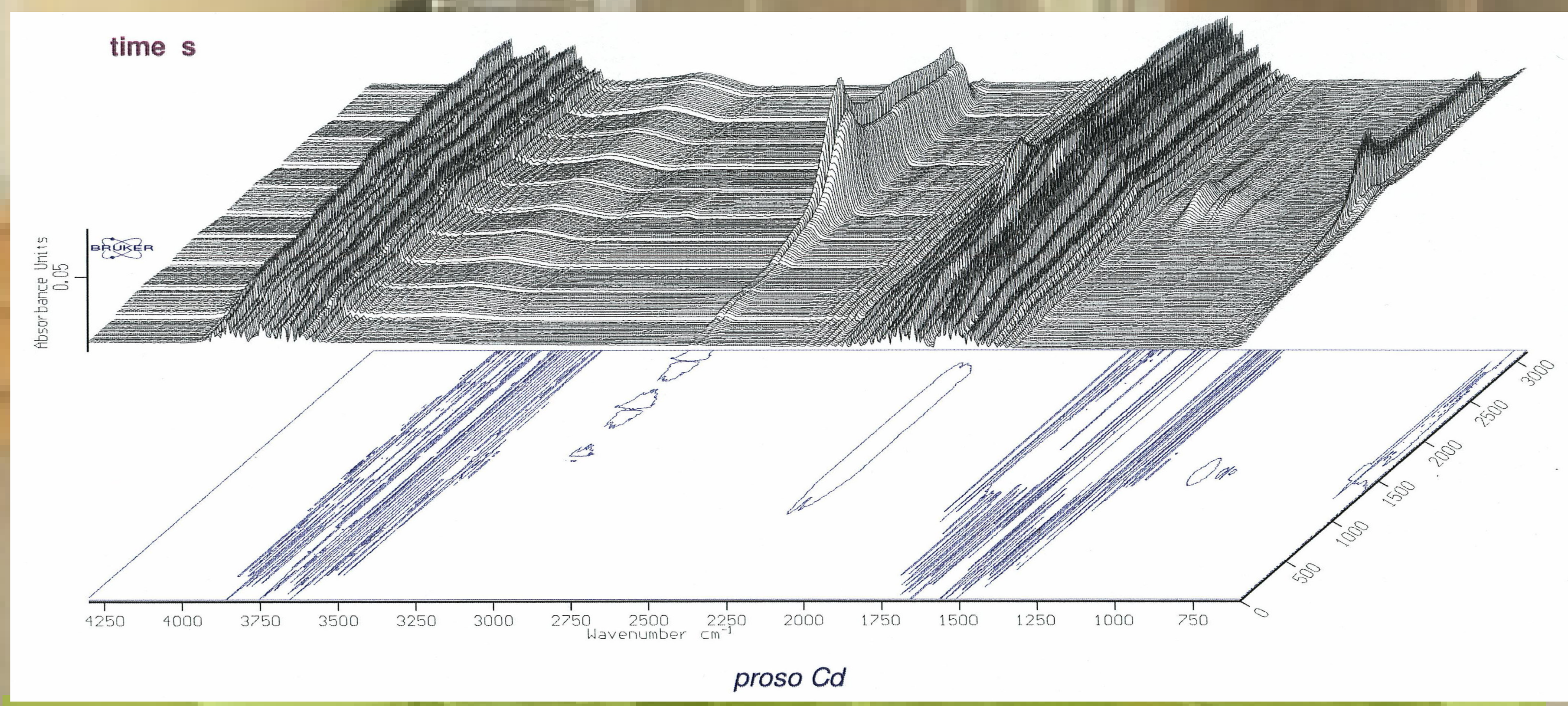


**Fig.2. FTiR analysis of torrified millet with Cd under isothermal conditions**

### BIOMASS CO-FIRING

Biomass co-firing with coal in conventional power plants is the main direction of polish and European energy sector development. Biomass has the biggest potential from all kind of renewable energy sources in Poland. Unfortunately combustion of untreated biomass (which has significant amount of water and organic and mineral matter) cause series of technical and exploitation problems in pulverized boilers and other equipment.

All of problems during biomass co-firing which were described above can be solve after co-combustion process by mechanical removal of the ash deposition, mineral matter deposition on hex's surface or by cleaning mills or replacing them with the new one. This rise the operational and exploitation costs drastically and do not solve the sources of those problems. A promising biomass pre-treatment technology which is cost-effective and soon will be commercialize is called torrefaction. During biomass carbonization process a high reduction of oxygen and hydrogen amount occur compare to reduction of carbon because biomass is transform to more coal liked fuel called biocoal. Average caloric values of torrifed biomass is in the range of 18 to 23 MJ/kg, low humid content (1-6%) makes from biocoal a potential substitute fuel for organic coal

Biocoal is not perfect product which does not any disadvantages, a still low energy density is the main problem of torrefaction products, this mean that in practice torrefaction should be combined together with pelletization. Thanks to those two processes combined together we can get a torrefied pellets which are characterize with high energy density, low humidity, high humidity resistance and do not need a any special storage facilities

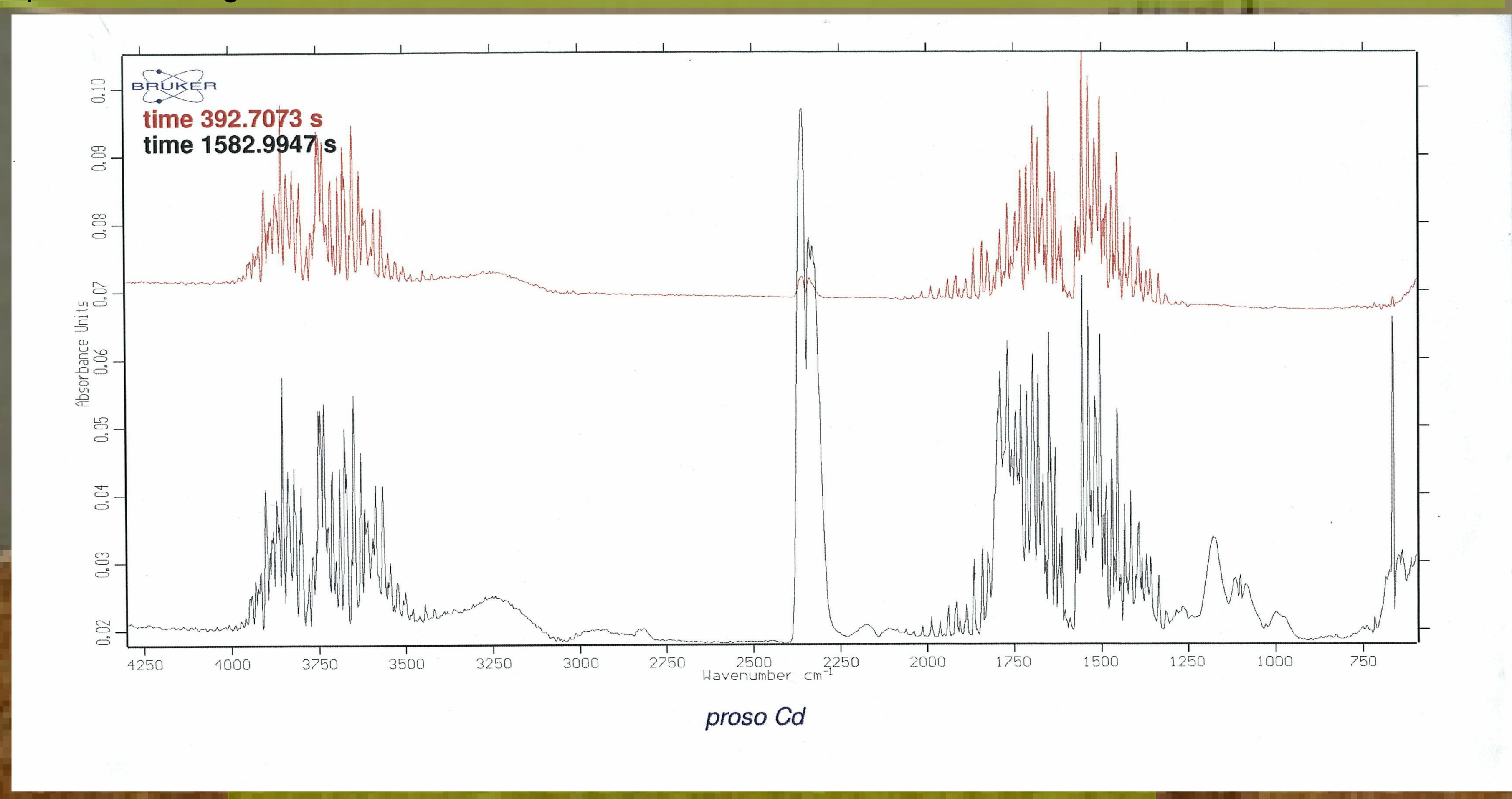


**Fig.5. Thermal analysis of pellets from straw wood**

### CONCLUSIONS

The first results on biomass torrefaction which was done in different condition: dynamic heating rate and static (isothermal conditions) and in different inert atmosphere: nitrogen and in argon shows that lower temperature under which maximum mass loss ration in time is observed in argon atmosphere (20° C lower temperature than in nitrogen atmosphere).Millet biomass which contain Cd shows different fraction of volatile matter than millet without Cd contain. Cadmium content do not slow down or make the torrefaction proeces faster but has influence on quality of end products of the proces. Also a quantity analysis of torgas (gas evaporating during biomass torrefaction from heated samples) and this gas content analysis will be done for other types of biomass like reed, willow, mallow and jerusalem artichokes.

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