INFLUENCE OF THE TIME OF AND STIRRING RATE DURING THE FIRST STEP OF SYNTHESIS OF SBA-15 ON ITS CATALYTIC EFFECT FOR REDUCING TOXICANTS CONCENTRATION IN TOBACCO SMOKE

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ABSTRACT

Various SBA-15 wewre synthetized at different time and stirring rate, during the first step of synthesis. The materials were characterized by RDX, N_2 adsorption isotherms, SEM and apparent density. 3R4F tobacco mixed with 4,8 % of such SBA-15 materials were smoked under ISO 3308 conditions. The effect of these variables on the catalyst toxicity reduction capacity has been studied.

INTRODUCTION

In recent years, the use of SBA-15 as additive for tobacco reducing toxicity has been proposed[1]. The dependence of the properties and structure of this materials on their synthesis conditions is very strong[2]. The objective of the present work is to study the effect of the time and stirring rate in the first step of the synthesis on their textural properties and their capacity for reducing the toxicity of tobacco smoke.

EXPERIMENTAL

SBA-15 was synthetized based on the method described by Zhao et al.[3]. Samples were prepared at different times: 6, 15, 20 and 24 h (at aconstant stirring rate of 700 rpm); and different stirring rates: 400, 700 y 1000 rpm (at constant 24 h duration).

TPM, tar and gas composition were determined. GC/FID technique was employed to analyse the gas fraction. The oven program started at 35 ºC using a heating rate of 5 º/min up to 100 ºC and 15ªC/min uo to 200 ºC, holding this temperature during 10 minutes. A GS-GASPRO column was used. CO and CO_2 in the gas fraction was analysed in an GC/FID at 300 ºC with a methanizer at 375 ºC and using a Porapak packed column at 60 ºC. Tar compounds were extracted with 2-propanol and the composition was analysed by GC/MS with an HP5-MS column from 40 to 320 ºC holding the last during 25 minutes. Compounds were classified by family of compounds and they were determined using the MS Wiley library. The reductions ($\%R_i$) were calculated as $100(r_i\text{-}rc_i)/r_i$, where r_i is the amount of compound i obtained in the test without SBA-15 and rc is the amount of that compound obtained with SBA-15.

RESULTS

The textural properties of the synthetized materials are shown in Table 1. The dimensions of a_0 did not show a significant variation depending on the variables studied. SBET seems to decrease with synthesis time. When studying the stirring rate, the textural parameters presented a minimum value for the sample at 700 rpm. The apparent density is a parameter not frequently determined, but has been proven to present a relevant importance in these application. The 15 h and 1000 rpm samples show relatively high values of this property. SEM micrographs (Fig. 3) present well-defined fibres, typical of these materials, except for the sample at 1000 rpm whose fibres are noticeably thicker, shorter and worse defined.

Table 1. Structural properties and % of reduction.

Sample	SBET (m^2/g)	ρ_a (g/cm^3)	a_0 (nm)	%R TPM	%R Nicotine	%R CO_2	%R CO
6 h	955	0.048	11.7	60.3	56.0	29.8	34.5
15 h	932	0.061	11.4	55.1	49.5	22.4	18.8
20 h	843	0.045	11.4	59.7	55.0	20.5	24.3
24 h	861	0.049	11.6	68.1	66.8	23.4	31.0
400 rpm	973	0.046	11.7	51.7	51.4	17.5	13.3
700 rpm	861	0.049	11.6	68.1	66.8	23.4	31.0
1000 rpm	933	0.062	11.7	42.5	34.1	21.4	19.9

%R are mesured about mg compound/g tobacco smoked

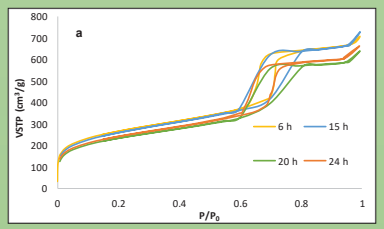


Fig. 1. a) N_2 adsorption isotherm and b) DRX for the study of time.

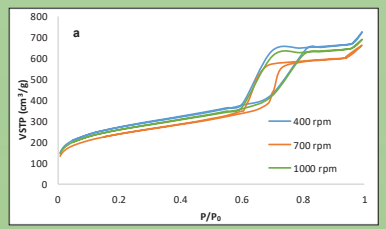


Fig. 2. a) N_2 adsorption isotherm and b) DRX for the study of stirring rate.

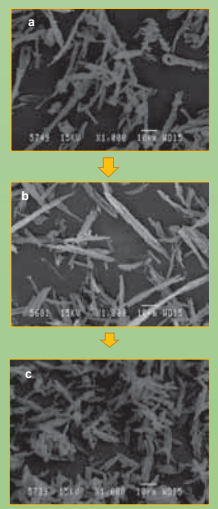


Fig. 3. SEM micrographs: a) 400 rpm, b) 700 rpm and c) 1000 rpm.

The variables time and stirring rate have a direct impact on the applicability of the materials. In the series where the duration of the process is studied (Table 1 and Fig. 4), a general improvement of the reductions can be observed by increasing the time in tars, nicotine and the families of compounds in TPM. When analysing the series in which the stirring rate is varied (Table 1 and Fig.5), the effect of the apparent density and the structure of the fibres is clearly observed, which cause a marked reduction on catalytic effect in the 1000 rpm sample. In this way, a maximum reduction ability is obtained for most families of compounds, both in liquids and gases.

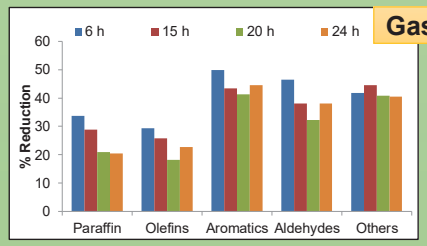


Figure 4. Reduction for the different families in the gases and TPM for the study of time.

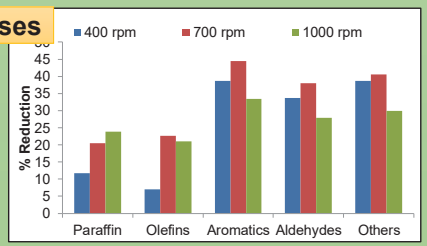
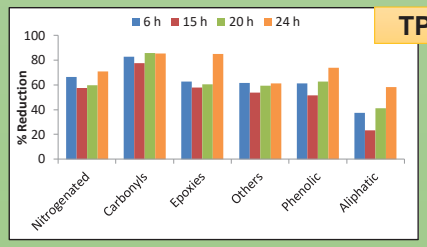
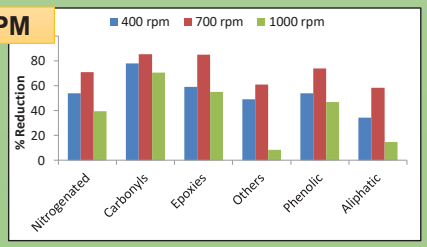


Figure 5. Reduction for the different families in the gases and TPM for the study of stirring rate.





CONCLUSIONS

The characterization of the materials has shown the typical properties of the SBA-15 type of materials. The duration of the fisrt step of the synthesis process seems to increase the ability of this materials for reducing the generation of toxic compounds in the tobacco smoking process, specially in the condensed fraction, nevertheless, all samples provide large reductions. Stirring rate provides a maximum of effectiveness at 700 rpm, probably as a consequence of the change in the morphology of the material and the increase in the apparent density observed in the samples at 1000 rpm.

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