Preparation of titania membrane supports for treating nuclear waste

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Porous ceramic membranes comprise an important membrane category of particular interest in applications which require high chemical and thermal stability. Inorganic ceramic membranes have an asymmetric multi-layer structure. Their structure is composed of a macroporous support which is sufficiently permeable, strong and suitable for the deposition of an intermediate layer [1-2]. This work investigated the effect of sintering temperature and corn starch content on the permeability and mechanical properties of the support, ceramic produced from a commercial Degussa P25 titanium dioxide with a particle size of approximately 21 nm, consisting of a mixture of anatase (~80 %) and rutile (~20 %). In the preparation of the ceramic support in disk form, three suspensions of TiO_2 containing corn starch as pore-forming agent were used in proportions of 0, 15 and 30%. The suspensions containing 10% w/w of binder (PVA) were dried in the spray dryer (Figure 1) producing granulated powder, followed by pressing uniaxial and sintering at temperatures of 900, 1100 and 1150 °C/1h.

Figure 1 – Spray dryer installations at IEN

The effect of sintering temperature with concentrations of the pore-forming agent was studied to obtain suitable pore size and apparent porosity. Table I shows the values of density and apparent porosity of the sintered supports at temperatures of 900, 1000, 1150 ºC.

Table I –Apparent density and porosity.

Content starch %	Sintering Temp ºC	Apparent density %	Apparent porosity %
0	1150	91.98	8.02
15	1150	82.07	17.92
30	1150	72.88	27.12
0	1000	92.69	7.31
15	1000	80.42	19.58
30	1000	72.17	27.83
0	900	92.41	7.59
15	900	79.10	20.9
30	900	63.92	36.08

It is well known that for the application of the membrane support, high permeability and strong mechanical strength are two desirable properties. The technical literature suggests that for preparing ceramic membrane support the porosity should be above 35% so that the support has good permeability properties. Analysis of the results obtained so far indicate that this level of porosity was achieved at the lowest sintering temperature employed, i.e., 900 °C and 30% pore-forming agent. For higher temperature, no permeability could be measured, since the level of sintering is very high due to densification, making the material unsuitable for support. Figure 2 shows the permeability values obtained for membrane support sintered at 900 °C (92.7 L $m^{-2}h^{-1}$ MPa).

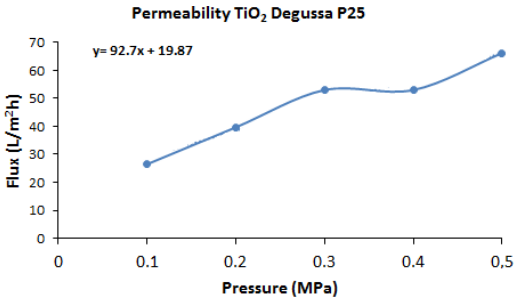

Figure 2 – Graphic of the permeate flow versus pressure TiO_2 Degussa P25

The results reveals that for the best conditions for such support, the sintering temperature of the TiO_2 Degussa should be 900 ºC and 30% of starch.

References

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