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DEGASSING RATES OF AS-RECEIVED AND PREVIOUSLY DEGASSED GRAPHITE

W. J. Gray

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Pacific Northwest Laboratory
Richland, Washington 99352

DISCLAIMER

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Graphite has potential for use inside the vacuum chamber of fusion reactors as limiters, wall armor, or as a curtain or liner that stands between the plasma and the first structural wall. It remains to be demonstrated, however, that the degassing rate of graphite can be reduced sufficiently for use in the high-vacuum environment of magnetic fusion reactors. The small amount of information available in the literature* does show that gas contents comparable to those of metals can be achieved for graphites that have previously been well degassed, but there is almost no information on degassing rates. Also, it is not clear whether degassing the graphite prior to its installation in a fusion reactor will be adequate or if it will somehow have to be degassed after it is already in place.

Degassing rates, in the present study, have been measured on cylindrical samples 19 mm dia. x 25 mm long of a nuclear grade of graphite. A pressure-rise method was used together with a capacitance manometer vacuum gauge. Pressures were typically in the range 1 to 10^{-3} Pa (7.5×10^{-3} to 7.5×10^{-6} torr) except for degassing rates less than about 4×10^{-11} Pa·m^3/s·g (3×10^{-10} torr·l/s·g) where the pressure never rose above 10^{-3} Pa.

Data in Figs. 1 and 2 were taken sequentially. That is for example, curves labeled "1" are for a sample that was first at 293 K for one hour, then at 1273 K for one hour, then at 2073 K for 20 minutes and so on. None of the data presented in these figures are corrected for the system's degassing rate which was on the order of 10^{-11} Pa·m^3/s·g as shown by the cross-hatched band. The implications of this are discussed below.

Fig. 1 shows that degassing rates less than 10^{-11} Pa·m^3/s·g can be achieved after degassing for 16 hours at 773 K and then for one hour at 2273 K. Thirty minutes at 2273 K is nearly as good when subsequent

*See, for example, reference 1.

degassing rates are measured at temperatures of 1773 K or less. Degassing rates less than those measured for the system alone imply that the graphite is actually adsorbing gas coming from the system. It follows that the degassing rates shown, particularly when they are less than for the system, should be considered as upper bounds on the degassing rate of the graphite. This is because measured degassing rates are the result of a dynamic process wherein some molecules are being adsorbed while others are being desorbed. Thus, if the system pressure were lowered substantially, the adsorption rate would decrease, but the desorption rate would remain unchanged at least initially.

It is unlikely that the high temperatures used to achieve the low degassing rates shown in Fig. 1 can be employed once the graphite has been installed inside a fusion reactor. Therefore, data of the type illustrated in Fig. 2 were taken to show degassing rates after more modest pre-heat treatments or high-temperature treatments that might be performed prior to installation. "Thoroughly degassed" means the sample was degassed for 16 hours at 773 K, then 80 minutes in the range 1273 to 1673 K, and finally for 30 minutes at 2273 K. It is shown that the room temperature degassing rate of a previously degassed sample that was then soaked in room air is not much different from an as-received sample. All other conditions shown result in degassing rates orders of magnitude less than for as-received samples though still substantially above that for freshly degassed samples as shown in Fig. 1.

As a point of reference, the degassing rates presented here can be compared approximately with room temperature values for degassed stainless steel[2] of about 5×10^{-13} $Pa \cdot m^3/s \cdot cm^2$ even though the rates are expressed per unit mass for graphite and per unit area for stainless steel. Much higher rates for stainless steel can be expected at the elevated temperatures required for power producing reactors.

REFERENCES

1. G. A. Beitel, J. Vac. Sci. Technol. 8, p. 647 (1971).

2. Y. E. Strausser, Technical Report VR-51, Varian Associates, Palo Alto, CA (1968).

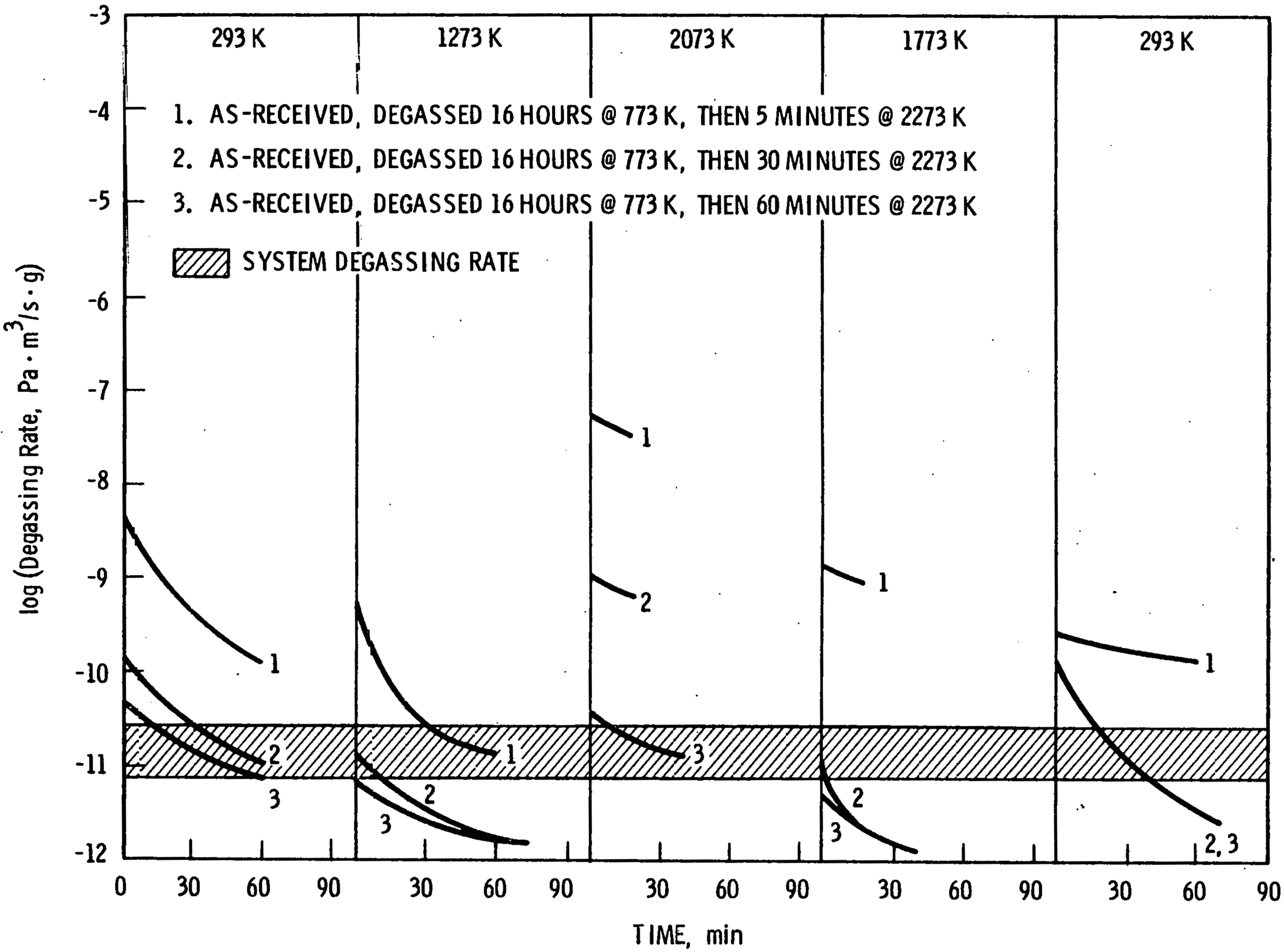

Fig. 1. Degassing rates of freshly degassed graphite.

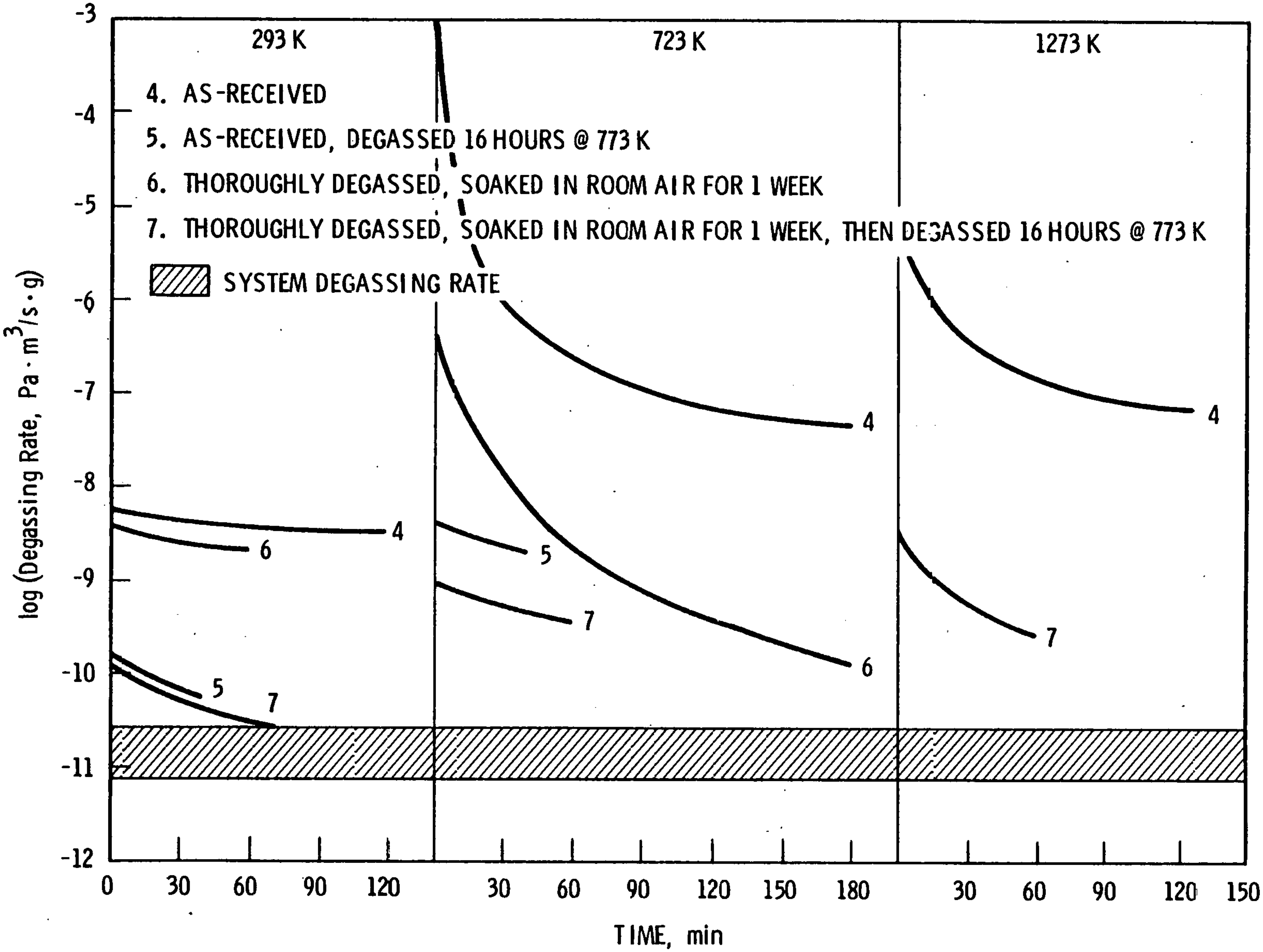

Fig. 2. Degassing rates of as-received and previously degassed graphite.