case of the constant directional pressure, two different answers exist. This is so because the fundamental path, in this particular case, is unstable.[5,6] The lower value of 3.27 is an upper bound and corresponds to the case of the nonvanishing mean rotation. In this case, the ring is allowed to slide freely on a single fixed axis while the higher value of 4 corresponds to the case when the ring is allowed to slide freely on a fixed cross.[5,6] The classical buckling load of all 3 cases otherwise agrees with the well-known ones.[2]

Finally, we might mention that the only initial post buckling behavior study of the ring under external pressure known to the Author is that of Ref. 3 for the cases of hydrostatic and constant directional pressure. However, the conclusion drawn there that the ring is imperfection sensitive[1] is erroneous due to inadequate formulations. The stability performance of the ring is dominated by bending and not membrane energy. This is the case with all structures with geometry and boundary conditions which allows quasi-inextensional deformation. To obtain the expected rise in the post buckling path, we have to consider nonlinear terms in the expression for the rotation. However, such terms are neglected in the expression for rotation used in Ref. 3. The Sanders' equations are appropriate only for problems in which the middle-surface membrane energy is dominating. Also, the two possible ways of holding the ring in space were omitted in Ref. 3. A similar result for the ring in an elastic foundation was given in Ref. 4. Thus. the ring possesses a symmetric stable point of bifurcation for a variety of loading and supporting conditions.

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Effect of Neutron Radiation on the Vaporization of Ammonium Perchlorate

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Nomenclature

α = fraction of ammonium perchlorate vaporized
k = rate coefficient for AP vaporization
t = time
$f(\alpha)$ = $1-(1-\alpha)^{1/2}$

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Table 1 Rate coefficients for the vaporization of a neutron-irradiated and non-irradiated ammonium perchlorate[a]

Run	T,K	mass,mg	$k \times 10^4$, sec^{-1}[b]
1	592	11.8	2.8
2	592	12.1	3.2
3	592	12.7	2.8
4	592	12.7	3.0
5[c]	574	13.6	0.49
6	576	13.1	0.53
7[c]	576	6.10	1.5
8	576	6.04	1.7
9[c]	576	6.00	1.7
10	576	5.92	1.7
11[c]	576	6.06	1.7
12	576	6.06	1.4
13[c]	577	6.08	1.6
14	577	6.10	1.9

[a] 0.1 l/min flow rate of argon.
[b] $1-(1-\alpha)^{1/2}=kt$.
[c] Neutron-Irradiated AP 4.2×10^{14} neutrons/cm^2.

Introduction

It has been well established that X-ray, γ-ray, and neutron radiation alter the induction period and low-temperature decomposition of ammonium perchlorate (AP).[1-7] These changes indicate that such radiation causes both physical and chemical changes in AP.[8] Such results shed no light on the effect of radiation on the combustion rate of AP or AP-based composite propellants. This is because a number of workers have repeatedly shown that it is possible to increase or decrease the rate of the low-temperature reaction and not affect the combustion rate of composite propellants made from the altered AP.[9-13]

To gain insight into the effect of ionizing radiation on composite-propellant combustion, we examined the effect of neutron radiation on the kinetics of vaporization of AP by isothermal thermogravimetry. The vaporization of AP is deemed the only condensed phase reaction relevant to the combustion of AP.[14] The neutron radiation will interact most strongly with the condensed phase. This knowledge of the effect of neutron radiation on the rate of vaporization of AP will enable us to infer the effect of neutron radiation on the combustion rate of AP, and AP composite propellants. To date no one has examined the effect of any form of ionizing radiation on the kinetics of AP vaporization.

Experimental

Finely-ground AP from Hercules Alleghany Ballistics Laboratory, Cumberland, Md., was used for these experiments. This is the same form of AP in SPRINT propellant. The AP was dried, and one-half of the sample subjected to neutron radiation at the Army Pulsed Radiation Facility, Aberdeen Proving Ground, Md. Sulphur dosimetry pellets were enclosed in the sample containment vessel to determine the neutron fluence. From appropriate calibration curves, the total neutron fluence of neutrons with energies greater than 1 kev was determined as 4.2×10^{14} neutrons/cm.[2]

The kinetics of the vaporization of loosely-packed AP was determined by isothermal thermogravimetry with a commercial thermogravimetric analyzer (duPont model 951). A previously discussed procedure was employed in order to have the AP sample reach thermal equilibrium within 30 sec after the AP was inserted into the furnace.[8] The kinetic runs were carried out near 570K after it was discovered that the irradiated AP deflagrated at 590K. At 570K both the low-temperature decomposition and the vaporization of AP could be distinguished, and only weight loss corresponding to the vaporization of AP was used to determine the kinetics of the vaporization. Since the rate of vaporization of AP depends on sample size,[14,15] care was taken to have similar sample sizes

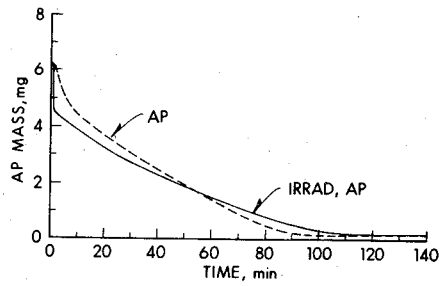

Fig. 1 Isothermal heating curve of irradiated and unirradiated AP at 576K.

when comparing the irradiated AP to the unirradiated sample. All kinetic runs were made in a flowing argon atmosphere.

Results

Figure 1 compares individual kinetic runs of the irradiated and unirradiated AP. The nearly vertical portion at the beginning of each run is the weight loss from the low-temperature decomposition. One can see in Fig 1 that the initial weight loss is more rapid for the irradiated AP and that the fraction of AP decomposing via the low-temperature path is slightly greater for the irradiated AP. Such observations are in accord with previous results.[7,8] The remaining portion of each kinetic run corresponds to the vaporization of AP which continues until all the AP is consumed. To see the effect of neutron radiation on the vaporization of AP, the weight loss corresponding to the vaporization of AP was converted to fraction reacted α and the fraction reacted vs time fit to several equations representing solid-state decomposition kinetics.[16] In accord with Jacobs and Russell-Jones,[15] the following equation was found to best represent the fraction reacted vs time

$$1-(1-\alpha)^{1/2}=kt$$

The rate coefficient k was calculated by a linear least-squares fit of $f(\alpha)$ vs t. Table 1 summarizes the rate coefficients computed in this fashion for all the kinetic runs we performed. Clearly the rate of vaporization of the irradiated AP is the same as the rate of vaporization of the unirradiated sample.

Conclusion

The vaporization rate of AP is unaffected by a neutron fluence of 4×10^{14} neutrons/cm^2, although the low-temperature decomposition is altered by the same fluence. One would expect the neutrons to primarily affect condensed phase reactions. The literature indicates that the rate of vaporization is the only condensed phase reaction deemed important in the AP combustion. Therefore one would expect a neutron fluence of 4×10^{14} neutrons/cm^2 to have no effect on the combustion rate of AP or the combustion rate of composite propellant made from irradiated AP.

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Dynamic Response of Laminated Composite Plates under Initial Stress

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Introduction

IT is a well known fact that an initial stress will modify the mechanical properties of a medium. As an example, a homogeneous and isotropic medium in the unstressed state may become nonhomogeneous and anisotropic under initial stress. In general, a tensile initial stress will stiffen the rigidity of the medium, while a compressive initial stress will

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