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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE  
JOINT FIRE RESEARCH ORGANIZATION

## THE GASEOUS PRODUCTS OF DECOMPOSITION OF CELLULOSE NITRATE-CELLULOSE ACETATE MIXTURES

by

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### SUMMARY

From published data on the gaseous products of decomposition of cellulose nitrate and cellulose acetate calculations have been made to determine the probable gaseous products of decomposition of mixtures of those two compounds under different conditions.

### INTRODUCTION

In connection with details of a specification for cinematograph films, information was required on the effect of the introduction of small amounts of nitrocellulose in cellulose acetate film and the resultant fire hazard particularly with regard to the toxicity of the gaseous products. From the figures given it was estimated that the highest proportion of cellulose nitrate to be used would be 10 per cent and some calculations have therefore been made of the volume and composition of the products of decomposition of such material when involved in a fire. The calculations are based on the work of J. C. Olsen, G. E. Ferguson and L. Schefflan, 1930, on the gases produced by the decomposition of nitrocellulose and cellulose acetate films. A summary of their results is given below in Table 1.

### CALCULATIONS

Table 1

Composition of gases from decomposition of cellulose nitrate and cellulose acetate

	Cellulose nitrate		Cellulose acetate	
	In absence of air	In excess air	In absence of air	In excess air
Total gas cc/g	379	5,425	61.4	5,000
CO % by vol.	34.1	5.3	42.0	7.9
Nitrous fumes % by vol.	38.0	0.3	-	-

For mixtures of cellulose acetate and cellulose nitrate containing 10 per cent of the nitrate the calculated composition of the products of decomposition are given in Table 2.

Table 2

Products of decomposition of cellulose acetate-cellulose nitrate mixtures

	Cellulose acetate-cellulose nitrate mixture (10% cellulose nitrate)			Cellulose acetate
	From nitrate	From acetate	Total	
<u>Decomposition in absence of air</u>				
Total gases cc/g	37.9	55.3	93.2	61.4
Nitrous fumes % by vol.	38.0	-	15.5	-
Nitrous fumes cc/g	14.4	-	14.4	-
CO per cent by vol.	34.1	42.0	38.7	42.0
CO cc/g	12.9	23.2	36.1	25.8
<u>In excess of air</u>				
Total gases cc/g	54.3	4,500	5,043	5,000
Nitrous fumes % by vol.	0.3	-	0.03	-
" " cc/g	1.63	-	1.63	-
CO per cent by vol.	5.3	7.9	7.6	7.9
" cc/g	28.8	356	385	395

DISCUSSION

It is quite clear that the most dangerous effect of added cellulose nitrate occurs when the decomposition occurs in absence of air, conditions which may be closely approximated to in fires in large stores of this material. In this case the volume of gas evolved is increased by over 50 per cent and the toxicity is increased by the introduction of some 15 per cent of nitrous fumes while the carbon monoxide content is similar to that of the products of decomposition of cellulose acetate alone. The exact effect of the nitrous fumes, particularly in the presence of carbon monoxide and other gases, could only be discussed competently and fully by a medical authority; however, according to Henderson and Haggard (1943) nitrous fumes will produce a comparable toxic hazard at a concentration about one tenth of that required for carbon monoxide, and in the case under consideration the addition of 10 per cent cellulose nitrate will result in the production of nitrous fumes equivalent to the extent of just over one half the volume of carbon monoxide produced by the cellulose acetate above. When an excess of air is present, the effect of the cellulose nitrate is very much reduced, the increase in the volume of gases produced is negligible and the concentration of nitrous oxide is so small in comparison with the carbon monoxide that it is unlikely to be of importance. In an actual fire it is probable that the conditions will be intermediate between the two extremes quoted above.

REFERENCES

Y. Henderson and H. W. Haggard, 1943. Noxious Gases. Reinhold Publishing Corp. New York.

J. C. Olsen, G. E. Ferguson and L. Schefflan, 1930. Ind. Eng. Chem. 22 760.