A Study on the Grinding Process of HMX using Fluid Energy Mill

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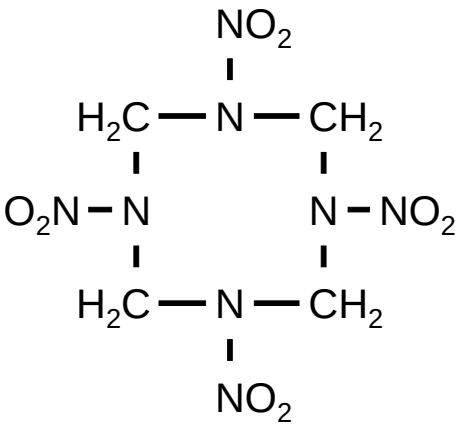
Introduction

Characteristics of HMX

- 1,3,5,7-tetranitro-1,3,5,7-tetraazacyclooctane (Octogen), $C_4H_8N_8O_8$
- High performance explosive
- 6 differential class
- Dv = 9.1 km/s
- Sensitive of Impact and Friction

→ Coated it with polymer binder and plasticizer



Ref) ICT database & MIL-DTL-45444C

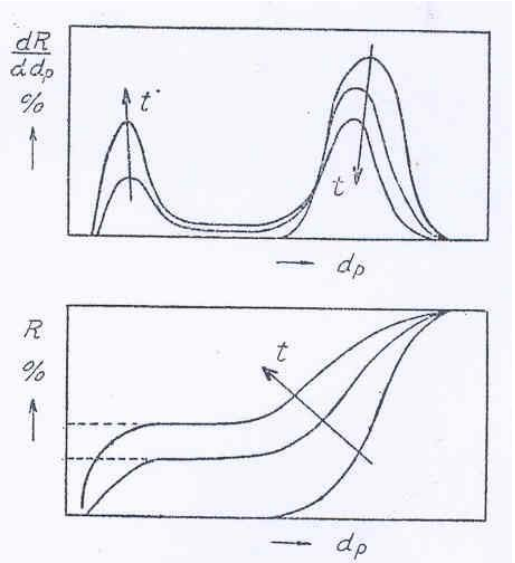
Introduction

Aim of this study

- Study on the grinding process of HMX using fluid energy mill
- Find the optimum operating parameters for the purpose of average particle sizes below 5□ in the process of HMX grinding

Background

Process of Grinding through jet



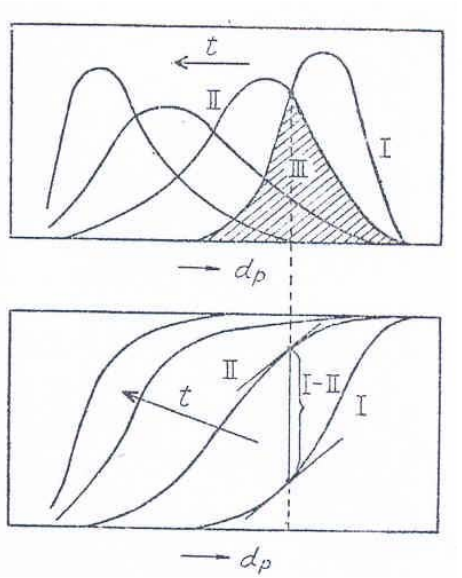
☐ Type I

- relatively hard material (ex, Silica sand)
- the mechanism of separation through attrition
- the separation of particles occur primarily within the surface or in the edge
- the characteristics of the particles are maintained throughout the process of separation
- progressively as the quantitative amount of the larger particles diminish, there occurs a dramatic production of the smaller sized particles simultaneously
- during the grinding process, the formation of particle distribution retains and maintains a similar format

Ref) Y.Mori, G.Jimbo, *J. Chem. Eng. Of Japan*, 22, 363 (1958)

Background

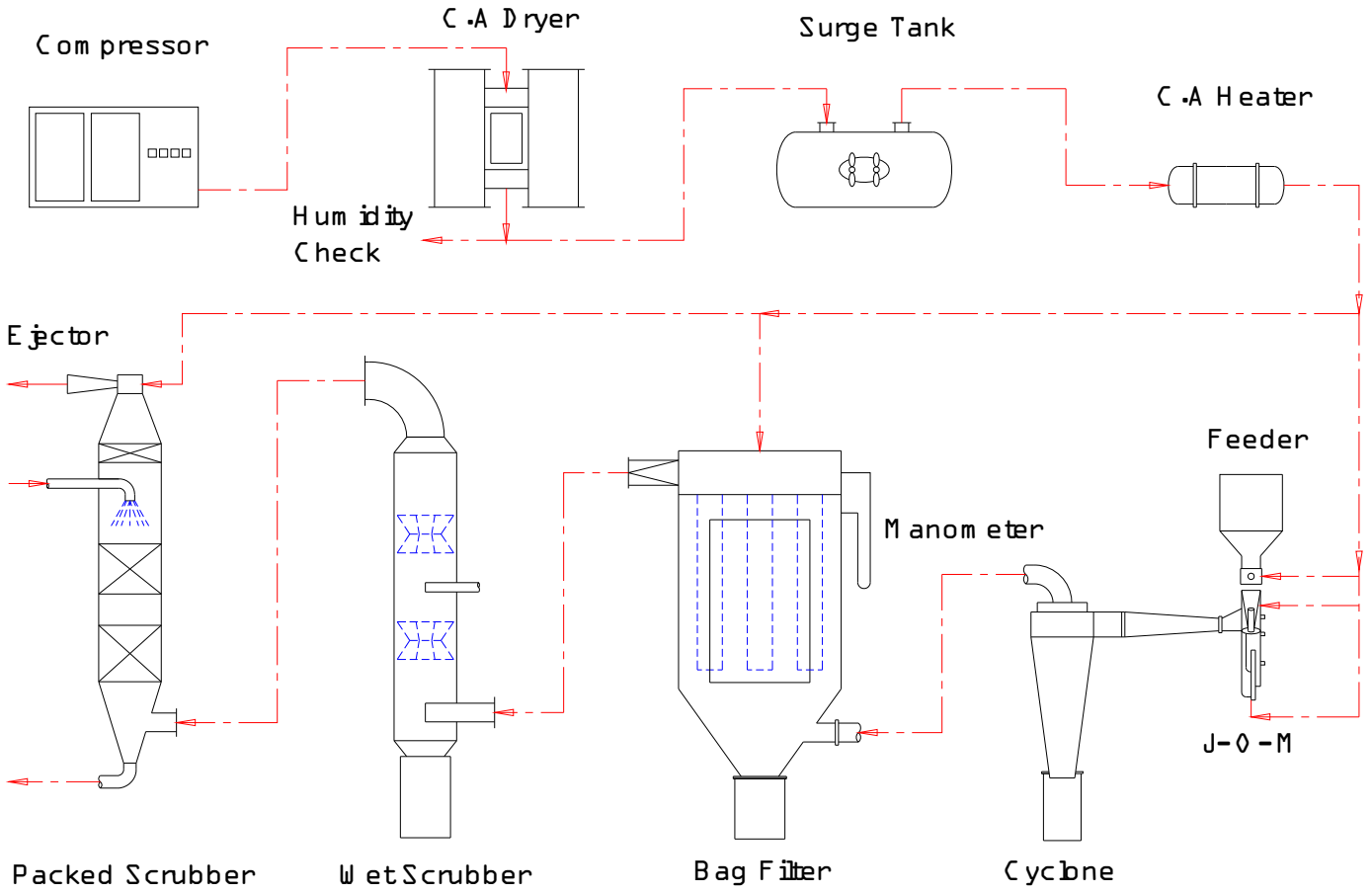
Process of Grinding through jet



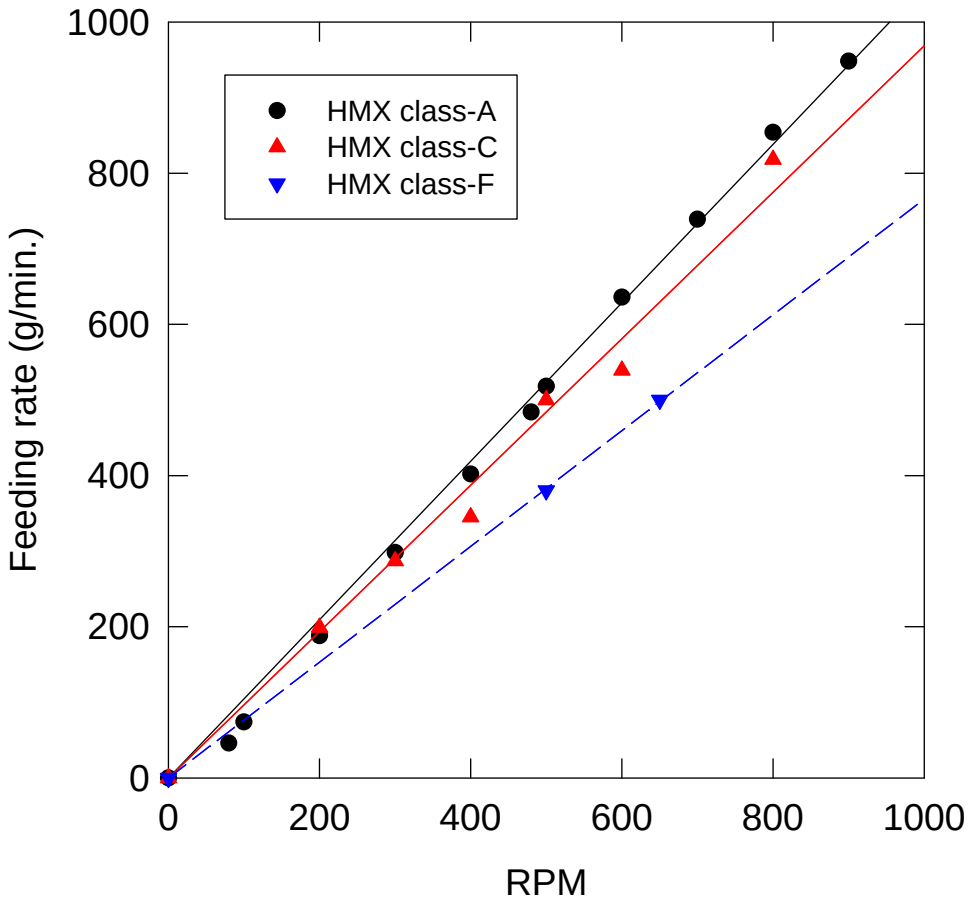
- Type II
  - relatively soft material (ex, Sulfur)
  - the mechanism of separation through fracture
  - when the particles are exposed to a greater amount of internal stress than it's capacity and are thus fractured and broken down into smaller particles subsequently
  - all particles become smaller compared to its original size and the status of particle distribution is also gravitated towards the smaller side

Ref) Y. Mori, G. Jimbo, *J. Chem. Eng. Of Japan*, 22, 363 (1958)

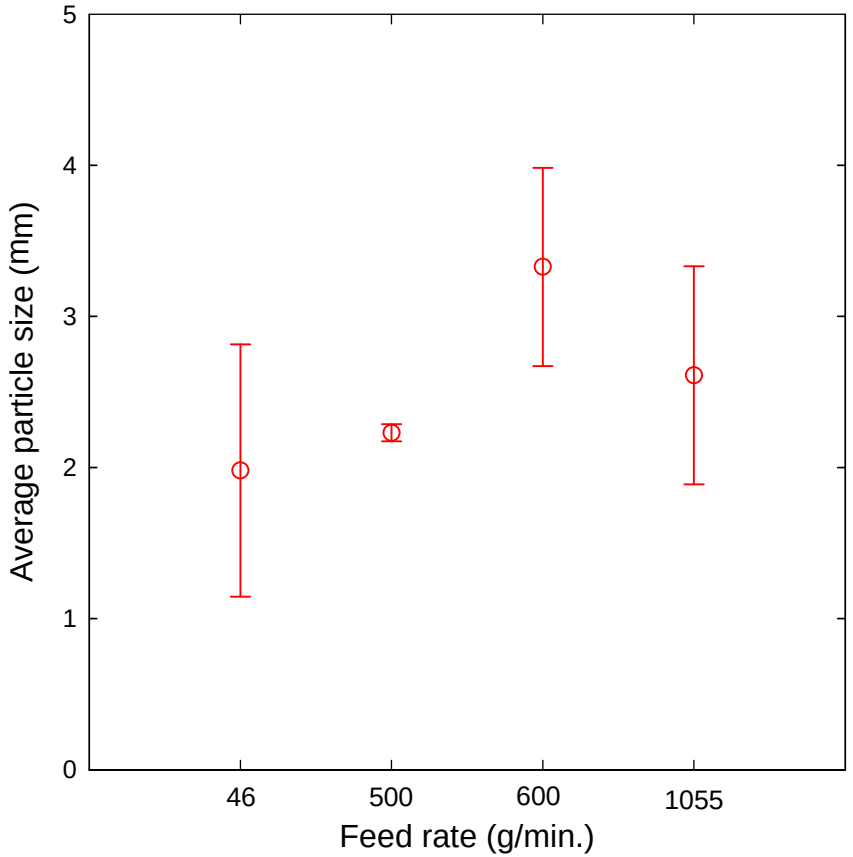
Schematic diagram of Fluid Energy Mill (J-O-M)



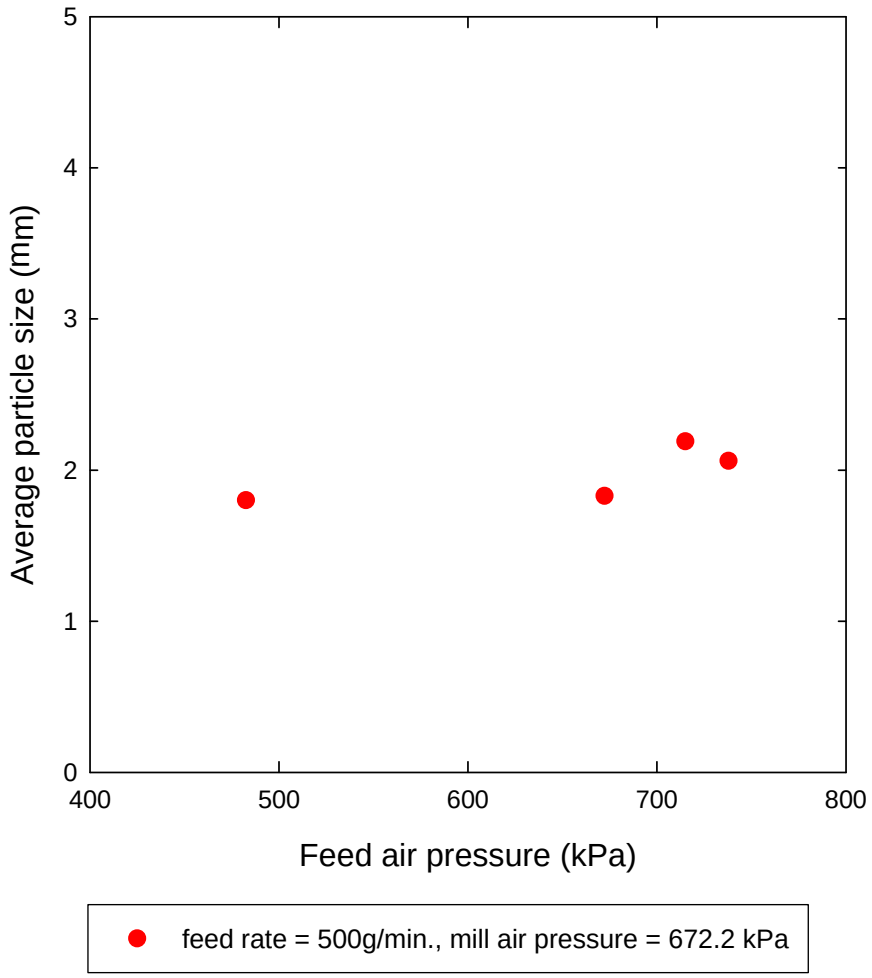
Calibration curves of Volumetric feeder



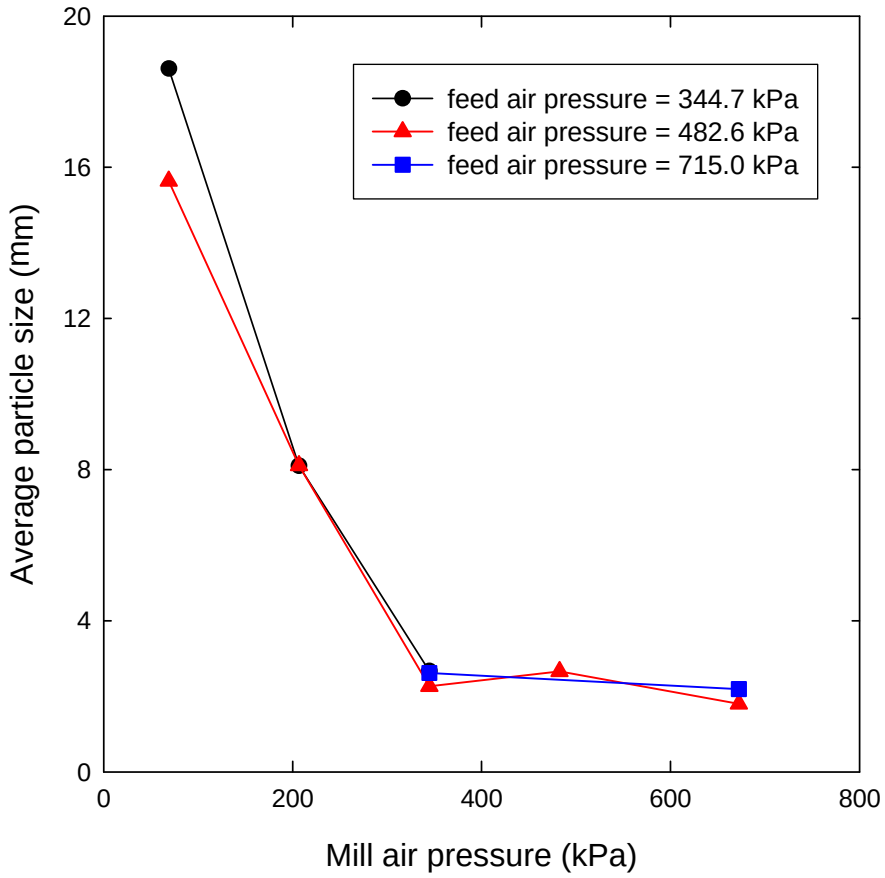
The effect of the grinding material's feed rate



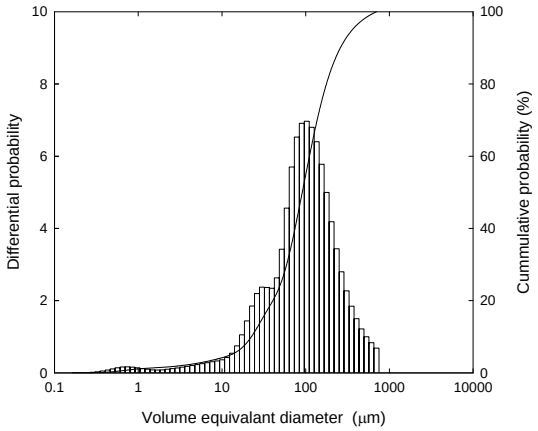
The effect of feed air pressure



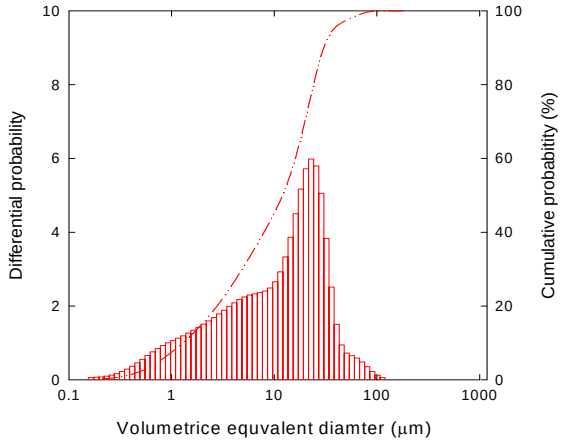
The effect of mill air pressure at constant feed rate



The grinding result according to variations in mill pressure



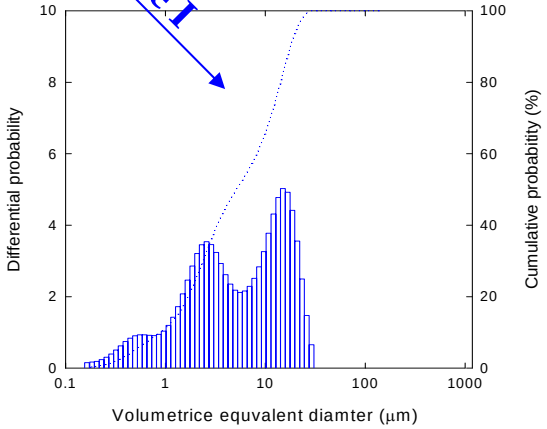
Type II



Mill pressure : 70kPa

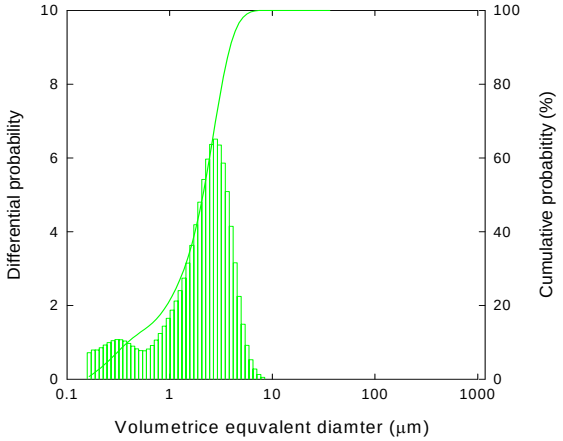
Before Grinding

Type I



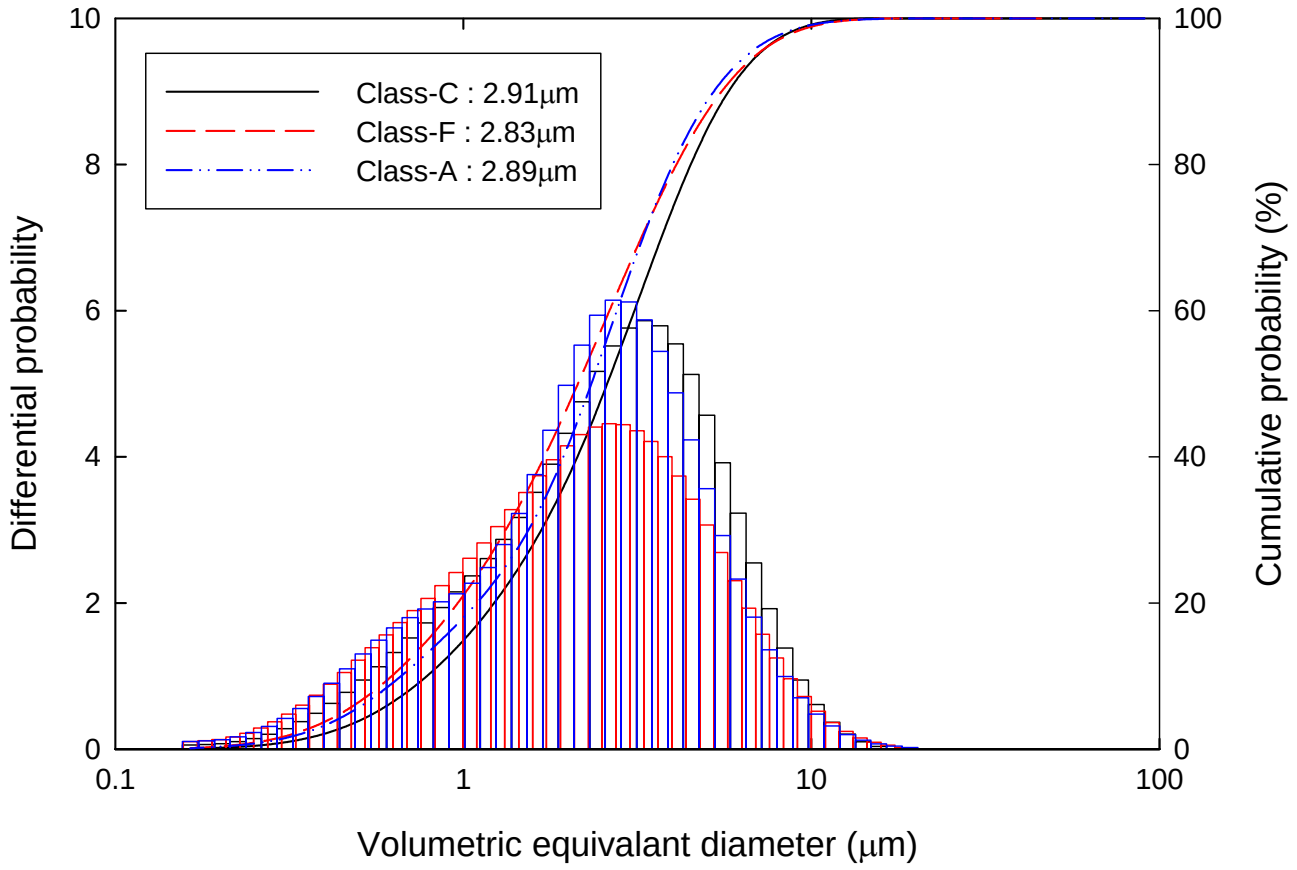
Mill pressure : 200kPa

Type II



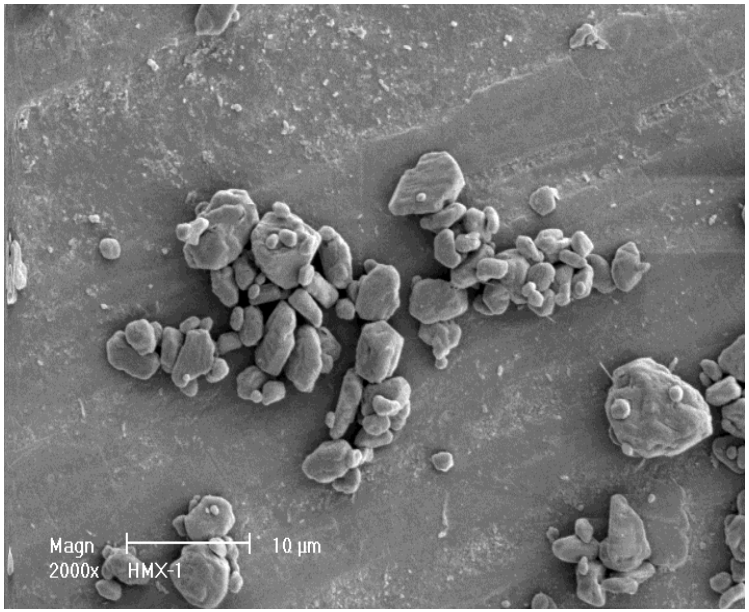
Mill pressure : 340kPa

The grinding results of HMXs with respect to average particle size variation



Pre & Post Grinding process SEM images of HMX

Before Grinding



After Grinding

Conclusions

- **The particle size and distribution were greatly influenced by mill air-pressure, but feed air-pressure and feed rate had little effect.**

- **When the air-pressure exceeds 340kPa, we can stably obtain an average fine-powder particle size below 3□ regardless of feed rate.**

- **Under the normal circumstances and conditions within the operation of the JOM, with increase in air pressure, we were able discern the co-existence of the 2 different types of grinding mechanisms.**

Conclusions

- **Through the SEM image analysis, the fine-powder particles which underwent grinding were found to have a smooth surface and clean surface.**

- **We judge this to contribute towards the added insensitivity of the plastic bonded explosive's characteristics.**