고점도 도료의 압력손실 및 분사량에 관한 연구

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A Study on Pressure Drop and Flow Rate of High Viscosity Paint

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Key Words: Pressure drop(압력손실), High viscosity(고점도), Spray(도장)

Abstract : We have studied on the main causes of pressure drop in the paint hose under the spraying with airless spray pump and suggest calculation method for selecting the optimum pressure drop during the spraying. Among many factors contributing the pressure drop during the airless spraying procedure of paint, some of the key factors and the correct method for checking pressure loss between airless pump and spray gun are addressed. We have developed pressure loss calculation method which depending on hose length and diameter, viscosity and flow rate in the painting hose during the spraying. also we have developed calculation equation for the expected spray tip flow rate which depending on pressure and specific gravity and tip size.

1. 연 구 개 요

Pressure Drop (ΔP) in the Spray Hose

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Poor Spray Patterns & Coating Quality

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Evaluation & Compensation of ΔP
between Airless Spray Pump & Gun

- **Factors determining Coating Quality**
  - Coatings Materials & Applicator
  - Equipment : Control of Viscosity, Flow, Pressure
- **To achieve the Optimum Atomization**
  - Viscosity & Optimum Spray Pressure

2. 압력손실 및 분사량 이론식

▶ 압력 손실

- **이론식** : Darcy – Weisbach식에서 유도

$$\triangle P = \frac{40.74 \times \mu \times L \times Q}{D^4}$$

$\triangle P$ = 압력손실(Pa), μ = 유체의 점도(kg/m sec),
L = tube길이(m), Q = 유량(m^3/sec),
D = tube직경(m),

▶ 분사량

- **이론식** : 베르누이식에서 유도

$$Q = 425.75 \times \alpha \times d^2 \times \sqrt{\frac{P_g}{\gamma}}$$

Q = 토출 유량(LPM)
α = 유량 계수
d = Spray tip size ($inch$).
P_g = Spraytip에서의 압력(kg/cm^2).
γ = 유체의 비중

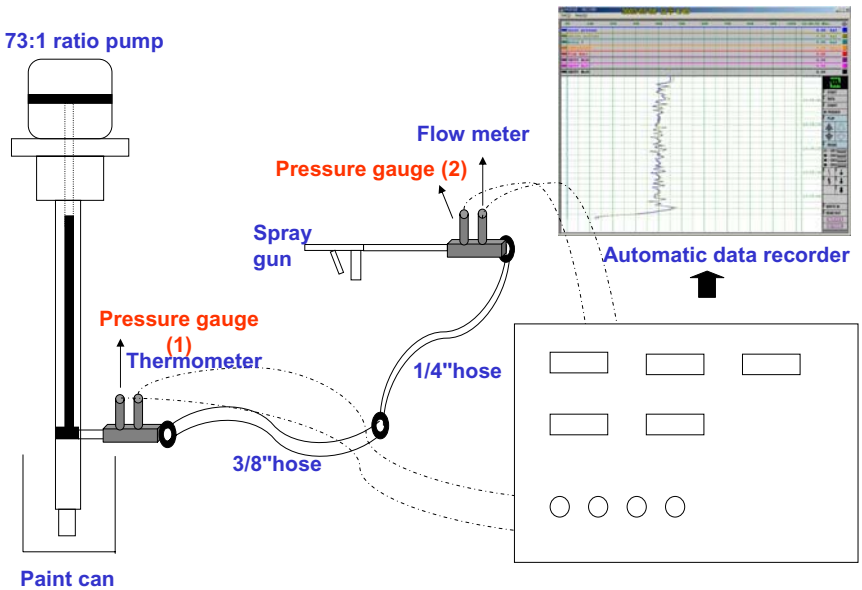
▶ 압력손실, 분사량 경험식

- **이론값과 실측값의 많은 차이 발생 → 실험으로 도출**

△P = f (점도, 유량, 직경, 길이 ...)

Q = f (Nozzle size, 압력, 비중, 점도 ···)

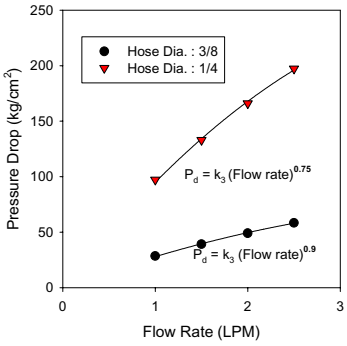
3. 실험 장치 및 방법



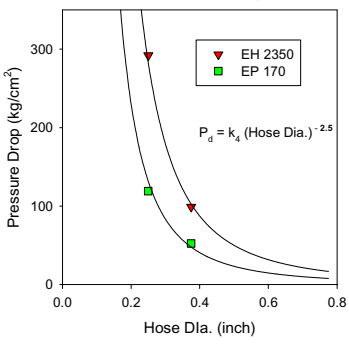
4. 결과 및 토의

4.1 압력손실

유량



호스직경

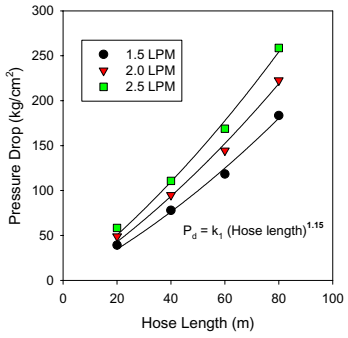


$$\triangle P = k_3 (Q)^{1.2\text{-}1.2D}$$

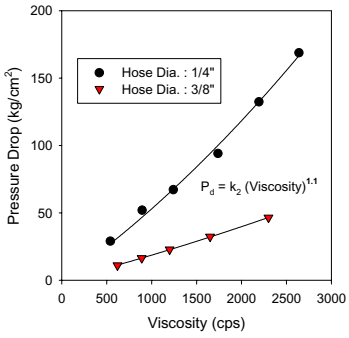
$$\triangle P = k_4 (D)^{-2.5}$$

4.1 압력 손실

호스길이



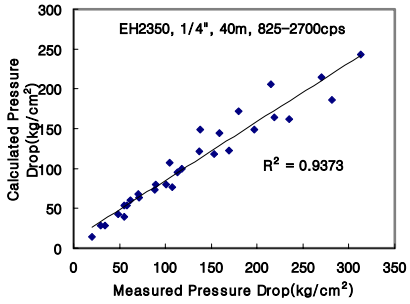
점도



$$\triangle P = k_1 (L)^{1.5}$$

$$\triangle P = k_2 (\mu)^{1.1}$$

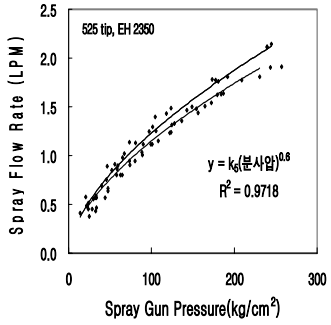
4.1.1 압력 손실의 경험식 평가



$$\triangle P = \frac{k \times \mu^{1.1} \times L^{1.15} \times Q^{1.2-1.2\times D}}{D^{2.5}}$$

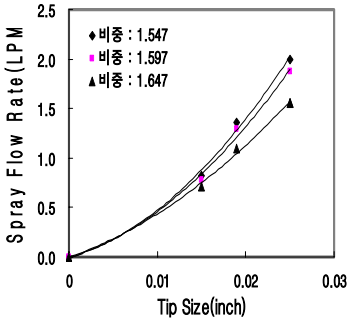
4.2 Spray 분사량

Spray 분사압



$$Q = k_5(P_g)^{0.6}$$

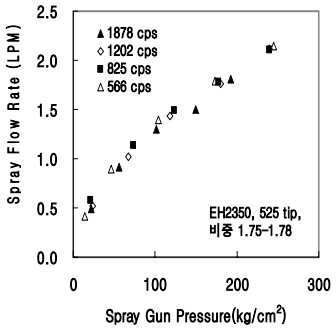
Nozzle 직경



$$Q = k_6(d)^2$$

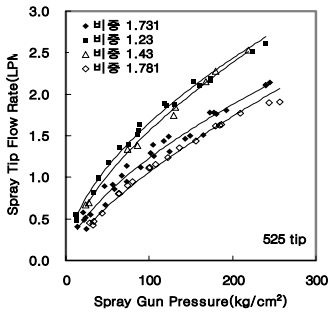
4.2 Spray 분사량

도료 점도



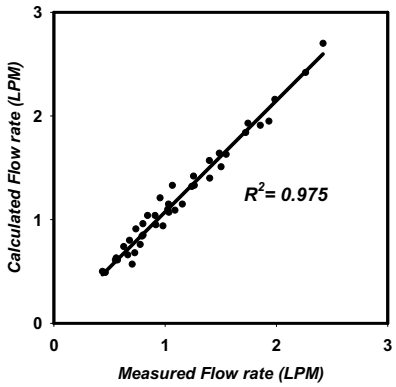
분무량은 점도에 무관

도료 비중



$$Q = k_7(\gamma)^{0.5}$$

4.2.1 Spray 분사량의 경험식 평가



$$Q = \frac{k_s \; d^2 \; P_g^{0.6}}{\gamma^{0.5}}$$

5. 결 론

◆ 도장호스내 압력손실 계산식 도출

$$\triangle P = \frac{k \times \mu^{1.1} \times L^{1.15} \times Q^{1.2-1.2\times D}}{D^{2.5}}$$

◆ Spray Tip 분사량 계산식 도출

$$Q = \frac{k_s \; d^2 \; P_g^{0.6}}{\gamma^{0.5}}$$