CEB CHEAT SHEETS
ADHESIVES MANUFACTURING
NHAN T. NGUYEN

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USUALLY, THE PMN IS AN INGREDIENT USED IN ADHESIVE FORMULATION. THESE CHEAT SHEETS ARE USED TO ESTIMATE OCCUPATIONAL EXPOSURE AND RELEASES OF THE PMN DURING ADHESIVE FORMULATION.

THE ASSUMPTIONS BELOW ARE TO BE USED ONLY WHEN THE REQUIRED DATA IS NOT AVAILABLE.

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* # OF ADHESIVE PRODUCERS
ABOUT 250 COMPANIES [FROST & SULLIVAN, 1981]
ONLY ~50 LARGEST COMPANIES HAVE SALES EXCEEDING $1 MILLION/YR (~.25 - .75 MILLION KG PER YEAR)
ABOUT 15-18 CARPET ADHESIVE PRODUCERS [CARPET DIALOGUE]

* BASIC INGREDIENTS
ASSUME: 1/3 ELASTOMER, 1/3 TACKIFIER, ~ 1/3 FILLER, 1% PLASTICIZER, 1% STABILIZER, .5% VISCOSITY CONTROL, .1% PRESERVATIVE, 1% ANTI-OXIDANT)

* **GIVEN (FROM PMN):** TOTAL MASS OF AN INGREDIENT

* **TOTAL MASS OF ADHESIVE (TMA) PRODUCED/YR** (IF NOT KNOWN) =
TOTAL MASS OF THE INGREDIENT / (%INGREDIENT ABOVE)

* **PROCESS DESCRIPTION**
INGREDIENTS ARE FED TO A MIXING VESSEL FROM DRUMS OR STORAGE TANKS ---> MIXING ---> PACKAGE INTO CANS OR DRUMS OR GALLONS

* **NUMBER OF SITES (NS)**

- **IF GIVEN:** USE METHOD 1 TO ESTIMATE # DAYS OPERATION
- **IF NOT GIVEN**
  - A. CALL THE SUBMITTER, ESPECIALLY IF TMA < 500,000 KG/SITE/YR, THEN USE METHOD 1, OTHERWISE
  - B. USE METHOD 2 TO ESTIMATE # DAYS OPERATION

* **DAYS OF OPERATION (DOP)**
ASSUMPTIONS: 4000 KG ADHESIVE/BATCH (~1000 GAL), 8 HOURS/BATCH, 1 BATCH/DAY, 1 SHIFT/DAY,

METHOD 1: IF NUMBER OF SITES IS GIVEN
PAPSPY (LB ADHESIVE/SITE/YR) = TMA / NS
DOP = PAPSPY / 4000

METHOD 2: IF NUMBER OF SITES IS NOT GIVEN
ASSUME: PAPSPY = 0.5 MILLION KG/YR
NS = TMA/PAPSPY = TMA/500,000
DOP = PAPSPY / 4000 = 125 DAYS

* **OCCUPATIONAL EXPOSURE**

TOTAL # WORKERS = (3-5/SITE)*(NS)

WORK DAYS/YR = DOP (PREVIOUS PAGE) OR 250

INHALATION

NEGLIGIBLE IF VP OF PMN < .001 TORR (FOR LIQUIDS)

TRANSFERRING/PUMPING

VAPOR (IF PMN IS A LIQUID)

1 WORKER/SITE OVER DOP (DAYS/YEAR)

A. IF FROM DRUMS TO REACTOR DIRECTLY OR TO STORAGE TANK:
* ASSUME 1 INCH PIPING

WORST:

$$Cv = 0.628*P*(1/29 + 1/M)^{.25} * (5) / (MW^{.165} * 2.54^{0.5})$$

THEN $Cm = Cv * MW / 24.45$

TYPICAL:

$$Cv = (\text{WORST CASE } Cv) / (30)$$

OR

B. IF FROM TANK CARS OR TANK TRUCKS TO STORAGE TANK:
* ASSUME 3 INCH PIPING

WORST:

$$Cv = 0.628*P*(1/29 + 1/M)^{.25} * (42) / (MW^{.165} * 7.6^{0.5})$$

THEN $Cm = Cv * MW / 24.45$

TYPICAL:

$$Cv = (\text{WORST CASE } Cv) / (30)$$

EXPOSURE (MG/DAY)= Cm * 1.25 ***(1 HR EXPOSED)***(% PMN CONC.)

OR PARTICULATES (IF PMN IS A SOLID)

USE ACGIH TLV POCKET BOOK, NIOSH POCKET GUIDE AND MONITORING DATA REFERENCES IF POSSIBLE

1 WORKER/SITE OVER DOP (DAYS/YEAR)

EXPOSURE (MG/DAY) = (150)*(%PMN)

ADHESIVES MANUFACTURING (PAGE 3)

SAMPLING (MIXING - MIXTURE IS NOW IN SOLUTION)
1 WORKER/SITE OVER DOP (DAYS/YEAR)

WORST
Cv (PPM) = $16*P*(1/29 + 1/MW)^{.25}/MW^{.165}$

THEN Cm = Cv * MW / 24.45

TYPICAL
Cv (PPM) = (WORST CASE Cv) / (53.33)

EXPOSURE (MG/DAY)= Cm * 1.25 ***(1 HR EXPOSED)***(% PMN IN ADHESIVE)

PACKAGING
1-3 WORKERS/SITE OVER DOP (DAYS/YEAR)

*** MAY NEED TO CALL TO SEE WHETHER A, B, OR C SHOULD BE USED**
*** IF WE KNOW IT IS EITHER A OR B, USE B TO BE CONSERVATIVE**

A. 1 GALLON CANS OR DRUMS
Cv (WORST) = 1.72*P Cv(TYPICAL) = 0.02*P
THEN Cm = Cv * MW / 24.45
OR

B. 5 GALLON CANS OR DRUMS
Cv (WORST) = 8.6*P Cv(TYPICAL) = 0.1*P
THEN Cm = Cv * MW / 24.45
OR

C. 55 GALLON DRUMS
Cv (WORST) = 95*P Cv(TYPICAL) = P
THEN Cm = Cv * MW / 24.45

EXPOSURE (MG/DAY)= Cm * 1.25 ***(1 HR EXPOSED)***(% PMN IN ADHESIVE)

DERMAL

TRANSFERRING/PUMPING FOR LIQUIDS
EXPOSURE = (1300-3900)*(%PMN CONCENTRATION)

TRANSFERRING/PUMPING FOR SOLIDS (FLAKES OR POWDERS)
EXPOSURE = (6500-18200)*(%PMN CONCENTRATION)

SAMPLING
EXPOSURE = (650-1950)*(%PMN IN ADHESIVE)

PACKAGING
EXPOSURE = (1300-3900)*(%PMN IN ADHESIVE)

* **DAILY ADHESIVE PRODUCTION (DAP)** IN KG/SITE/DAY = PAPSPY/DOP

* **RELEASES**

SOLIDS OR WATER RELEASE (MATERIAL REMAINING IN DRUMS)

ASSUME:

* 0.1% OF PMN MATERIAL REMAINING IN DRUMS

RELEASE = (0.001)*(DAP)*(%PMN CONC.)
-----> **SOLIDS WASTE DISPOSAL OR POTW**

WATER RELEASE (WR) IN KG/SITE/DAY **(FROM MIXING TANK)**

ASSUME:

* 1% OF ADHESIVE IS LEFT IN MIXING TANK
* SOLVENT-BASED ADHESIVES ARE CLEANED W/ SOLVENT USED IN NEXT BATCH -----> NO RELEASE
* WATER-BASED ADHESIVES ARE WASHED W/ WATER AND SENT TO POTW (AS WORST CASE)

WR = (.01)*(DAP)*(%PMN IN ADHESIVE)
----> **POTW** (WORST CASE)

SOLIDS RELEASE (SR) IN KG/SITE/DAY **(FROM SPILLAGE)**

ASSUME:

* 0.1% OF ADHESIVE IS LOST TO SPILLAGE DURING PACKAGING

SR = (.001)*(DAP)*(%PMN IN ADHESIVE)
------> **SOLIDS WASTE DISPOSAL**

AIR RELEASE (AR) IN KG/SITE/DAY **(WORKING LOSSES)**

ASSUME:

* 0.02% OF MASS USED IS BREATHING AND WORKING LOSSES (WORST CASE, PEI ACRYLATES REPORT)
* LIKELY LESS DUE TO SOME ENGINEERING CONTROLS TO REDUCE VOC EMISSIONS FROM SOLVENTS

AR = (.0002)*(DAP)*(%PMN IN ADHESIVE)
------> **TO ATMOSPHERE** (WORST CASE)

TERMINOLOGIES

Rubber Based Material: natural rubber, reclaimed rubber, polyisoprene, butyl rubber, SB copolymers, polyisobutylene, silicone rubbers, polyvinyl alkyl ethers, polyalkyl acrylates. Most resin base materials are thermoplastic polymers that function best at room temp; thermosetting resins are used mostly in electrical grade tapes.

Solid or Liquid Tackifiers: are used to increase the tack of the adhesive. Some of the common tackifiers are rosins and their ester derivatives, coumarone-indene resins, polyterpene resins, terpene-phenolics, thermoplastic phenolic resins, and vinyl toluene copolymers.

Inert or Reinforcing Fillers: or extenders are included to increase the cohesive strength, reduce the tack, impart some opacity or color, or lower the cost. The common fillers are zinc oxide, clay, aluminum hydrate, and calcium carbonate.

Plasticizers: improve the flexibility and platic flow properties. Some common plasticizers include: chlorinated biphenyl, formamide, phthalates, and polyacrylates.

Antioxidants: retard oxidation. Some common antioxidants include: armatic amines, and substituted phenolic compounds.

Solvents: facilitate handling and reduce the viscosity of the adhesive. Some common solvents include: alcohols, chlorinated solvents, esters, nitroparaffins, and ketones.

Preservatives: protect the adhesive from microorganism growth and spoilage. Some common preservatives include: aldehydes, benzoate esters, and phenolics.

REFERENCES

1. CARPET DIALOGUE NOTES.

2. PEI ASSOCIATES. OCCUPATIONAL EXPOSURE AND ENVIRONMENTAL ASSESSMENT OF ACRYLATES/METHACRYLATES

3. PEI ASSOCIATES.

4. SKEIST REPORT ON ADHESIVES.

5. SRI REPORT ON ADHESIVES.