# ELECTROSTATIC SAFETY DURING SOLVENT EXTRACTION

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## *Incident experience*

- *Fires have occurred at several solvent extraction plants in recent years*
- *Analysis has suggested that static electricity possibly responsible for ignition*



## *Basis for concern:*

- *Solvents used are hydrocarbon based*
- *Conditions may arise creating flammable atmospheres*
- *Hydrocarbon liquids often very insulating*
- *Liquid flow can cause electrostatic charging*
- *Ignition can occur if sufficient electrostatic energy is released in a static discharge*

## *Paper aims to show:*

*Fast dissipation of static charge in process liquids is a major requirement for safe operation of SX plants*

*Additional features need consideration for full safety against static electricity*



## *Objectives*

- *Discuss how ignition risks can arise with* ***static electricity***
- *Describe measurements needed to show freedom from electrostatic risks*
- *Outline actions to achieve safety*

## *Practical situations*

- *Normal operational conditions*
  - *Plant operational features*
  - *Personnel*
- *Failure situations*

*Safety should be based on avoiding at least two relevant ignition features*

*(e.g. flammable atmosphere and source of ignition)*



## *Ignition parameters*

***Ignition requires:***

1. *'Fuel' – from the process liquids*
2. *'Oxygen' – from the atmosphere*
3. *Source of ignition energy*

***Ignition energy sources:***

- *electrostatic sparks*
- *frictional sparks, hot particles*
- *pyrophoric reactions*

## *Basic questions*

- *Can flammable atmospheres arise?*
  - *-flash point of process liquids, temperatures*
  - *-maximum surface temperatures (solar gain)*
  - *-spraying, foaming*
- *Can sufficient electrostatic energy be stored at sufficient voltage and in such a way as to allow incendive sparks occur?*
  - *-are isolated conductors available*
  - *-rates of charging & dissipation*



## *Gas atmospheres*

*Noted 'smell' of solvent at Radomiro Tomic plant*

*- but all measurements showed near zero %LEL*

*Expected peak summer temperature 45°C still below kerosene flashpoint of 70°C*

***But:***

*- Solar gain may give higher temperature on exposed and black surfaces*

*-Pressure sprayed liquid from leaking joint or foam may be more flammable*

## *Normal plant operation*

***Electrostatic charging** can be expected:*

- *Flow, filtering and pumping of process liquids*
- *Rubbing of insulating surfaces*
  - *Pipework*
  - *Walkways*
  - *Clothing*
  - *Personnel*



## *Relevant electrostatic characteristics*

*Minimum energy for ignition by electrostatic sparks depends on ambient temperature, pressure and oxygen concentration:*

$$U = U_n f( T^{-2.0} P^{-2.0} O_2^{-3.9})$$

*- $U_n$ is the minimum ignition energy at normal temperature and pressure, etc – typically **0.2mJ for common hydrocarbons***

## *Electrostatic risks*

- *Main risks are of **sparks** from charged conductors*
  - *Isolated metal items*
  - *Personnel*

- *Risks possible from charged insulator surfaces*
  - ***but** much higher voltages needed*



## *Electrostatic measurements*

***Charge decay characteristics:***

*-Process liquids*
*-Garments*
*-Pipework*

***Surface voltages at rubbing:***

*-Fibreglass walkways*
*-Body voltages on walkways*
*-Foamimg surface of solvent in separation tanks*
*-Miscellaneous surfaces*

## *Testing body voltages on walkway*

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## *Surface voltage in separation tank*

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## *Charge decay test unit*

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## *Charge decay measurements*

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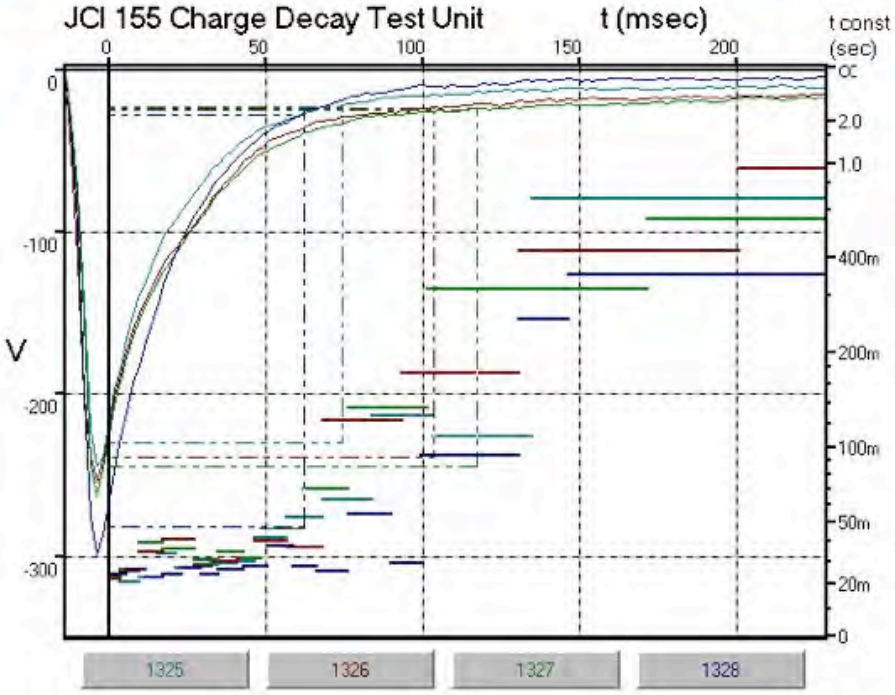
# *Charge decay loaded organic*

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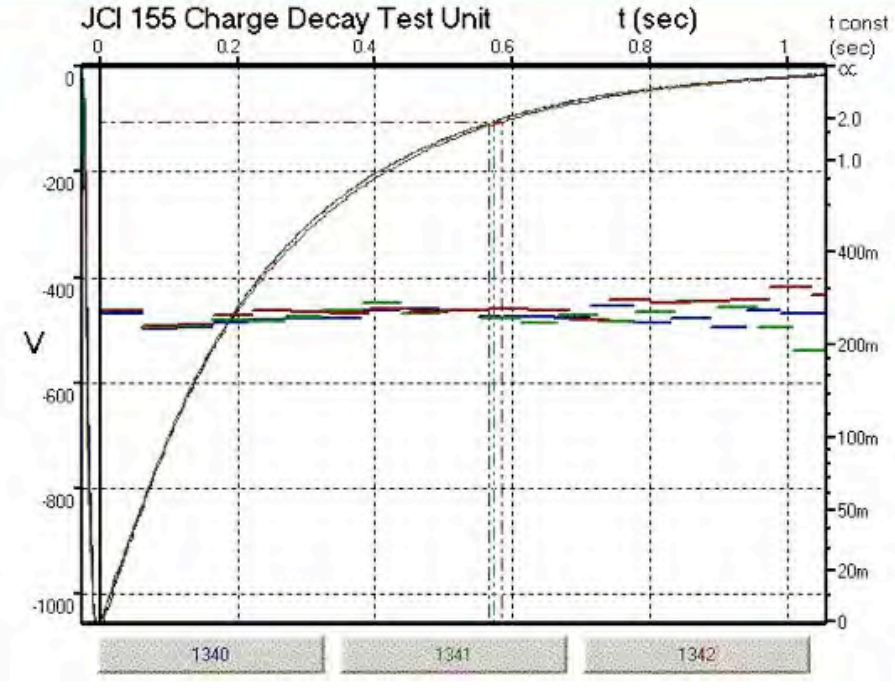
# *Extractente Agorga 5774*

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## Charge decay of process liquids

| | Decay time ($V_{pk} - V_{pk}/e$) (s) | Initial peak voltage (V) |
|---|---|---|
| Loaded process liquid | 0.028 | -249 |
| Unloaded process liquid | 0.025 | -425 |
| Fresh solvent (kerosene) | 0.480 | -791 |
| Fresh extractant (Acorga 5774) | 0.243 | -1053 |
| Fresh extractant M5640 | 0.328 | -965 |
| Fresh mixture (20/80%) | 0.402 | -846 |



## Charge decay of materials

| | Decay time ($V_{pk} - V_{pk}/e$) (s) | Initial peak voltage (V) |
|---|---|---|
| Company shirt | 570 | -1530 |
| Company overjacket | 8-17 | -1684 |
| Polypropylene liner | about 2000 | -1655 |
| Outside HDPE pipe | about 300 | -1920 |
| Inside HDPE pipe | about 4000 | -1300 |

## *Plant observations:*

***On-site studies** at Radomiro Tomic showed:*

- *No significant surface voltages on process liquid pipelines (despite HDPE)*
- *No significant voltages near liquid surfaces in tanks*

*This matched expectation from fast charge decay of process liquids*

*- **But** operators can become charged*



## *Conclusions (1):*

***Risks may arise:***

- *if liquids, pressure leaks and/or local temperatures allow flammable atmospheres*
- *if process liquids can become charged*
- *if isolated metalwork can become charged*
- *if people can become charged (e.g. walkways, clothing, etc)*

## *Conclusions (2):*

***Safety from static electricity requires:***

- *Process liquids with short charge decay time (high conductivity)*
- *Attention to all features where static may arise and be retained*
- *Plans for action to protect people in emergency situations*



## *Conclusions (3):*

- *Incidents and studies indicate that risks CAN arise from static electricity in SX plants*

- *On-site studies at Radomiro Tomic show*
  - *that basic operation **CAN** be safe*
  - *that process liquids exist with suitable ability to dissipate static electricity*

# *References:*

[1] J N Chubb, P Lagos J Lienlaf *"Electrostatic safety during the solvent extraction of copper"*
J. Electrostatics 63 (2005) p112-127

[2] G L Hearn and P E P Smithson *"Static Electricity – A Danger Inherent in the Solvent Extraction Process"* Paper at World Summit on SX Fire Protection, Alta 2005 Conf. Perth, Australia