Schneider Filtration Systems

Technical Bulletin

1 May 1992

Static charges related to hydrocarbon-based coolants used in the cold rolling of aluminum

Fundamentals of Static Electricity

Static electricity is generated by the separation of like or unlike bodies[1]. When two bodies that have been connected are separated, both the positive and negative electrostatic charges are split apart. This can manifest in a spark which in the presence of a proper fuel-air mixture can cause ignition.

For greater charges to be developed, the bodies must remain insulated from one another. Insulation may occur because the bodies are completely physically separated or because at least one of the bodies is an insulator; in this case a low-conductive rolling oil. When the oil is not flowing it contains equal quantities of positively and negatively charged ions and is electrically neutral. The tank and pipe containing the oil have a preferential attraction to one particular charge, either positive or negative, leaving the oil with a surplus of ions of the opposite charge at the interface of oil and pipe. As the oil starts to flow charging develops. This charging occurs as a result of the adsorbed ions separating from the free ions. That is, the turbulence created by the friction between the pipe and the oil pulls the ions at the interface from the oppositely charged ions in the pipe. Consequently the higher the oil velocity, the higher the friction and the higher the expected charge.

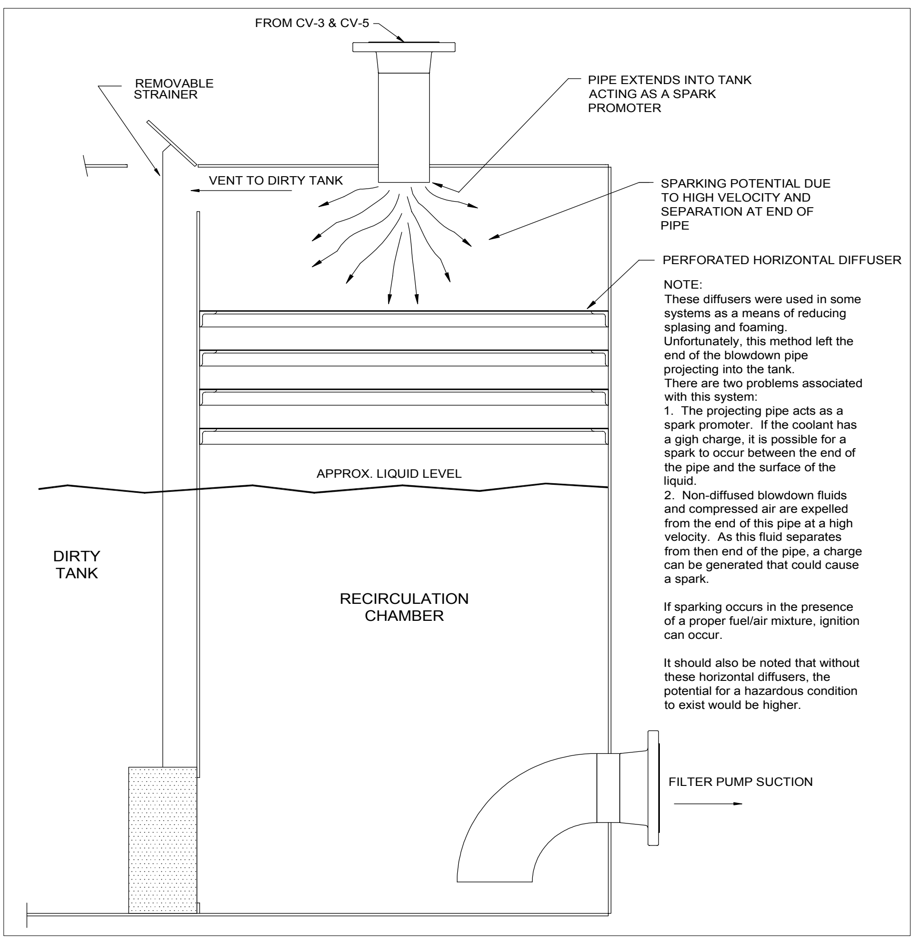

Figure 1 - Recirculation Design (Not Recommended)

The charge associated with the pipe or tank will usually leak away and recombine with their counterparts even if the ground has a resistance as high as 1 megohm. The oil, on the other hand, with a high opposite charge can cause sparking when the oil "separates" from the end of a pipe at a high velocity. This sparking can also cause ignition if the conditions are proper.

History

In June of 1989, the J.R. Schneider Co. issued a technical bulletin[6] discussing how to ground the rubber hoses on the Schneider filter to dissipate any static charge that might develop there. This static charge phenomena was witnessed when small sparks were observed between the reinforcing wire in the hose and the grounded hose connection (metal pipe) when there was coolant (oil) moving through the hose. Although no ignition incidents were ever reported we recommended grounding the metal wire to the grounded metal hose connection to alleviate a potential problem.

Recently another source of static charge was brought to our attention and it is the intent of this bulletin to inform those operating or designing coolant systems of the potential problems surrounding static charges.

We have been advised of two fires that occurred in the recirculation chamber of a coolant system on a high speed light gauge sheet mill (see Fig.1). Whereas the filters on this system were designed and built by the J.R. Schneider Company, the coolant tanks, piping and pumps were not. These fires occurred during the filter blowdown sequence about 2-1/2 months apart. The fires were quickly extinguished when the blowdown air supply to the Schneider filter was shut off. The damage was only cosmetic but the cause of the fires created concern.

The recirculation chamber in the coolant tank is used to contain filter aid in suspension such that the filter pump can then deliver it to the filter during the precoat cycle. It also functions as a tank to hold the blowdown liquids which may contain filter aid (a combination of diatomaceous earth and Fuller's earth). Two major lines from the filter, CV-3 and CV-5, usually join into one larger line that then enters the top of the recirculation tank.

Early Design

Investigation of the recirculation chamber in the subject coolant tank (see Fig.1) indicated that the design was different than that which has typically been recommended by the J.R. Schneider Co. The major difference was the "diffuser" that was used to reduce the splashing of incoming coolant in the recirculation tank. The subject design had four horizontal diffusers located about 12" from the top of the tank and about 2" apart. The diffusers were made of perforated sheet and were welded to the sides of the 3' by 3' tank.

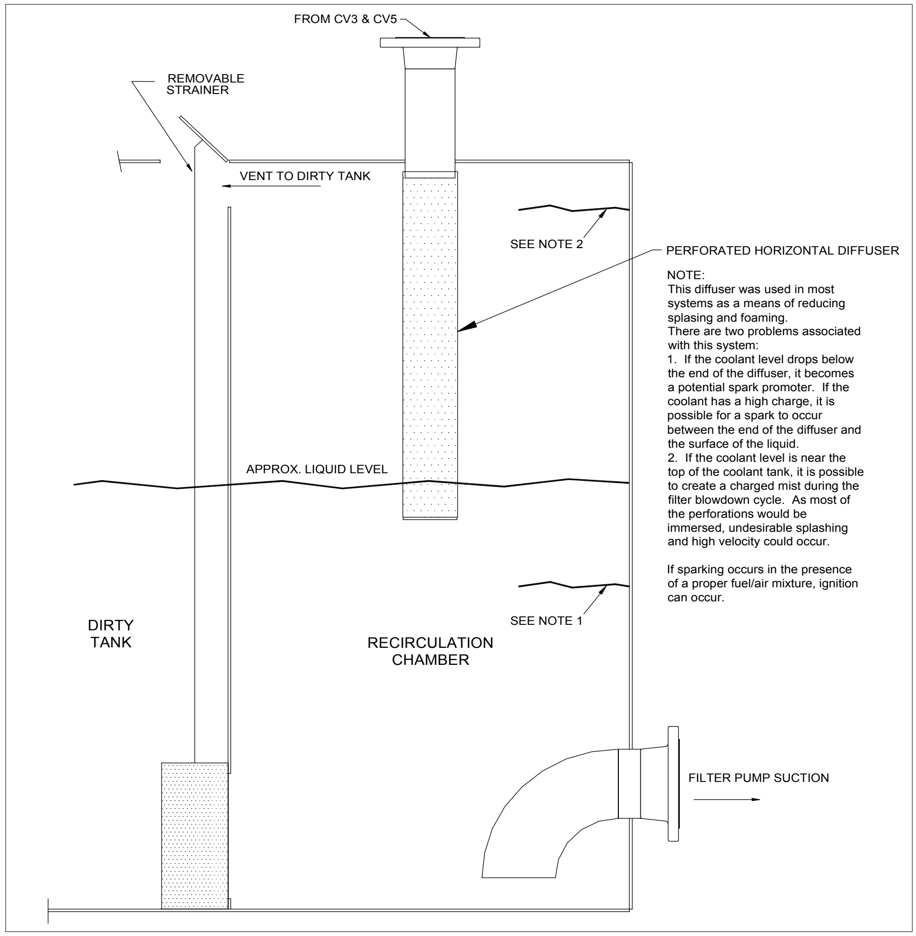

Figure 2 - Recirculation Design (Not Recommended)

In contrast, the J.R. Schneider Co. design called for a circular diffuser on a vertical axis. (see Fig. 2). This design diffuses the incoming blowdown liquid as well as coalescing the misty phase of the blowdown into droplets.

Conclusion

It became apparent that without the later type diffuser a highly static charge could build up between the end of the pipe and the first horizontal diffuser. Without the ability to coalesce the mist into droplets and dissipate the charge to ground we believe an unstable condition was created that caused a spark from the high potential mist to the side of the tank or from a high potential to low potential in the mist itself. This spark could have ignited the hydrocarbon mist causing the ensuing fires which eventually were extinguished when all the oxygen in the tank was consumed. It is possible that this sparking condition occurred during other blowdown sequences (over three hundred blowdown sequences occurred before the first incidence) but that the fuel/air mixture was not right for ignition.

Recommendations

Discharge lines

All coolant discharge lines into the coolant tanks should be directed below the surface of the liquid. This will prevent splashing which can contribute to the generation of electrostatic charges. If these lines enter from the top of the tank they should be extended to make contact with the bottom of the tank as shown in Fig. 3. If these lines enter from the side or bottom of the tank, deflectors or other devices should be used to avoid spraying that can form an ignitable mist. In either case the velocity in the pipe should not exceed 3 fps until the pipe discharge is completely submersed in coolant and all possibilities of spraying are eliminated. 15 fps should not be exceeded during normal operations. The exception to this would be the recirculation line as shown in Fig.4.

The recirculation line directs the flow from CV-3 and CV-5 the recirculation chamber. During the blowdown sequence coolant is pushed out of the filter with compressed air through CV-3 and CV-5 and into the recirculation chamber. After most of the coolant has been forced from the filter the compressed air is then used to dry the filter cake. This air is discharged through the diffuser above the surface of the liquid to prevent splashing.

The J.R. Schneider Co. recommends modifying all existing recirculation lines from CV-3 and CV-5 and the associated diffuser to reduce sparking potential. At present, we believe installations that conform with the design shown in Figure 4 will be effective.

Temperature sensors

Temperature sensors should be located inside the dirty tank near the vent openings between the recirculation and dirty tank. The temperature limit should be set between 200º and 250º F. If the temperature in the tank reaches this setting the filter should be disabled and an alarm beacon should be lit. By disabling the filter additional coolant would be prevented from entering the tank as well as stopping the blowdown air if the filter is in the cleaning cycle.

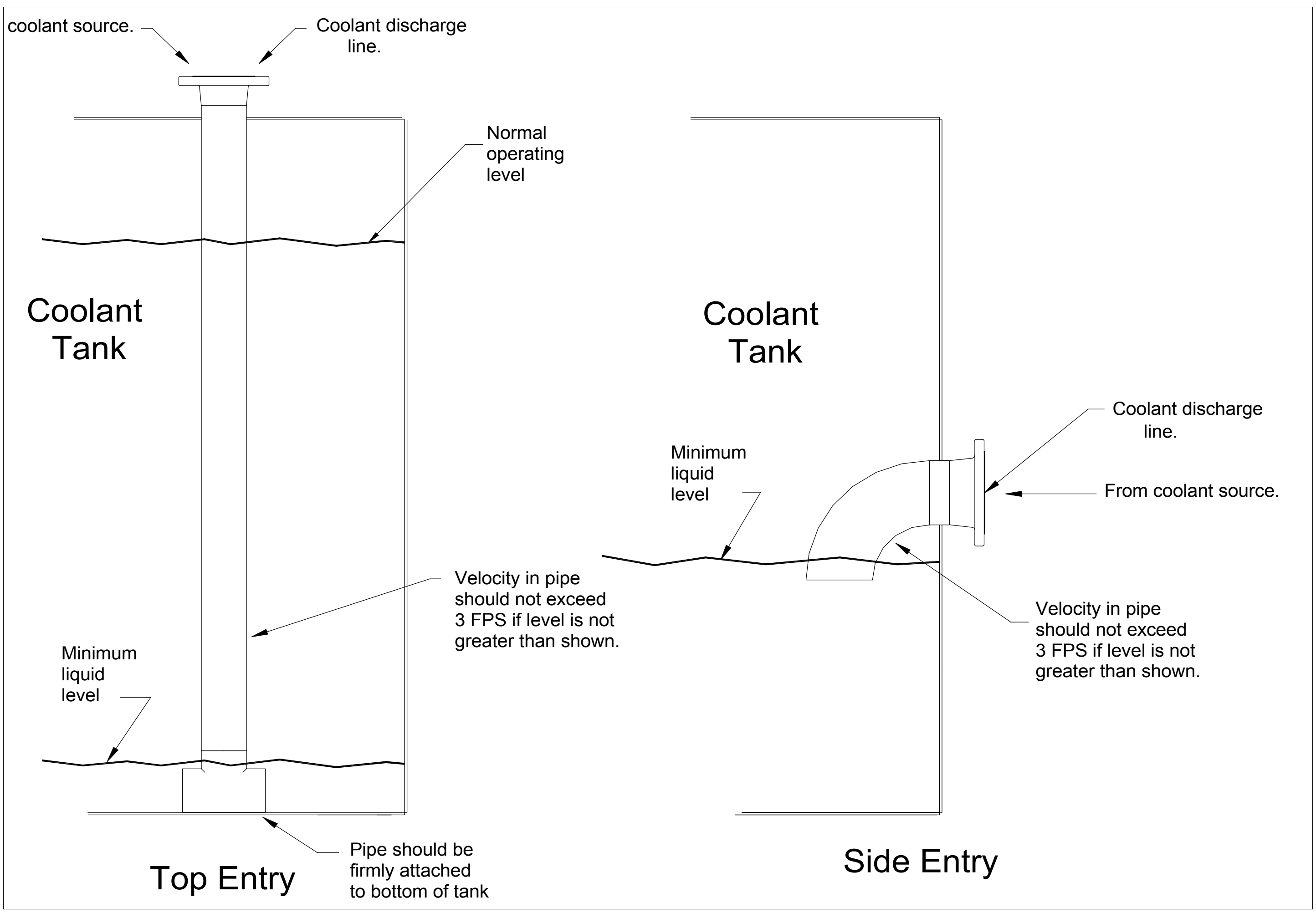

Figure 3 - Recirculation Design

Potential spark promoters

Conductive objects extending into the tanks have the potential of acting as lightning rods if the surface of these coolants have a high surface charge. Such items are float switch or float valve balls, pipe lines extending above the liquid surface, level indicating probes, thermocouple wells, etc. These items become a likely object for a static spark and bonding these projections to the bottom of the tank is one method of avoiding this phenomena (see Fig. 5 for a typical bonding technique). Another method employs a non-intrusive device such as a sonar level indicator that would replace a float ball and/or probe.

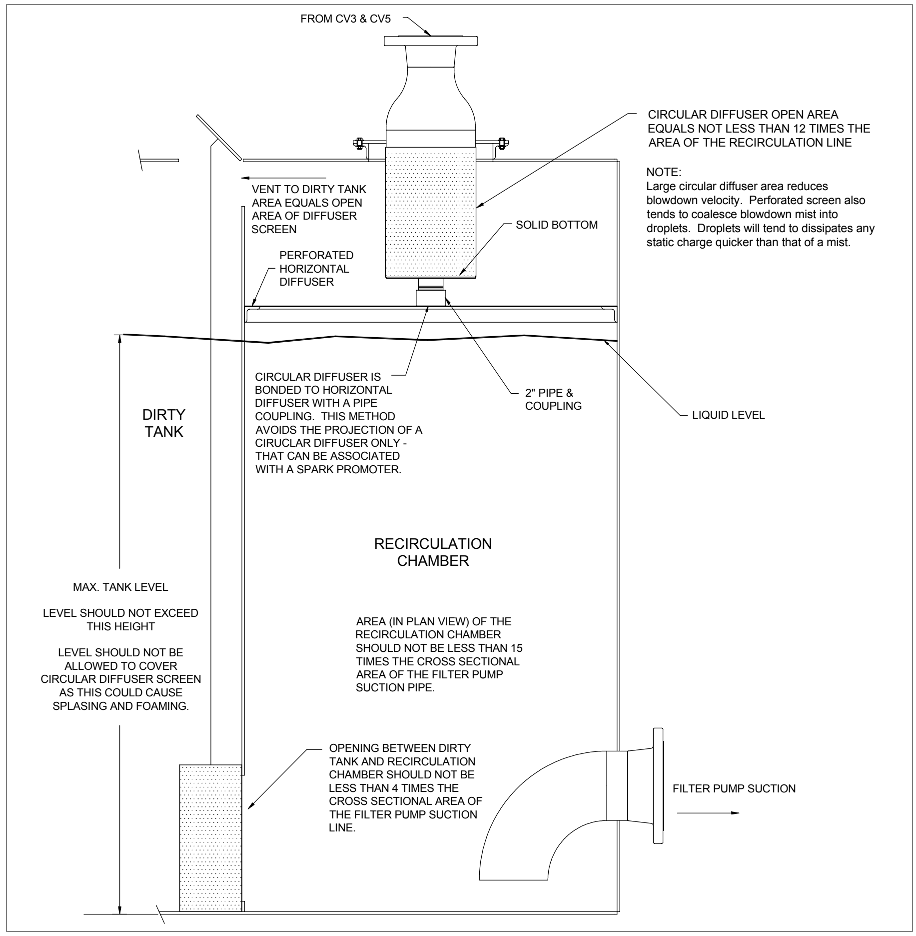

Figure 4 - Recirculation Design

Grounding

Storage tanks on grade-level foundations are considered inherently grounded for dissipation of electrostatic charges, regardless of the type of the type of foundation (concrete, sand, asphalt)[1]. The resistance to ground can be as high as 1 megohm (1 million ohms) and the tank can still be considered adequately grounded. The addition of grounding rods and similar grounding systems will not reduce the hazard associated with electrostatic charges in the coolant. The National Electric Code and local electrical codes should always be followed.

Lose connections

Access hatches, flanges, unsupported pipes, etc. should be properly connected such that any intermittent contact between ferrous metallic parts is avoided. This would prevent mechanically generated sparks from occurring.

Anti-static additives

The use of an additive in the rolling oil (coolant) as a means of increasing it's conductivity is an option to reduce the relaxation time necessary to dissipate a given charge. It should be noted that these additives only prevent the accumulation of charges and do not effect the rate of generation.

The following items are for REFERENCE ONLY and are NOT considered practical for existing coolant systems:

Inert Gas Blanketing and Blowdown

The use of an inert gas such as nitrogen or carbon dioxide as a purge gas to displace oxygen, is a method of preventing ignition. This method would have to be used as a blanket on the tanks and as a blowdown medium to replace compressed air.

Relaxation time between filter and point of discharge

Because electrostatic charges constantly leak from a charged body (oil) to a body of an equal and opposite charge (pipe or tank), it is possible to reduce a given charge by a practice known as relaxation. The API suggests that a 30 second relaxation period should be provided between the filter and the point of discharge to allow for this bleeding of charge to occur. If this were to be a chamber or a length of pipe it should be kept full to prevent the existence of an explosive fuel\air mixture.

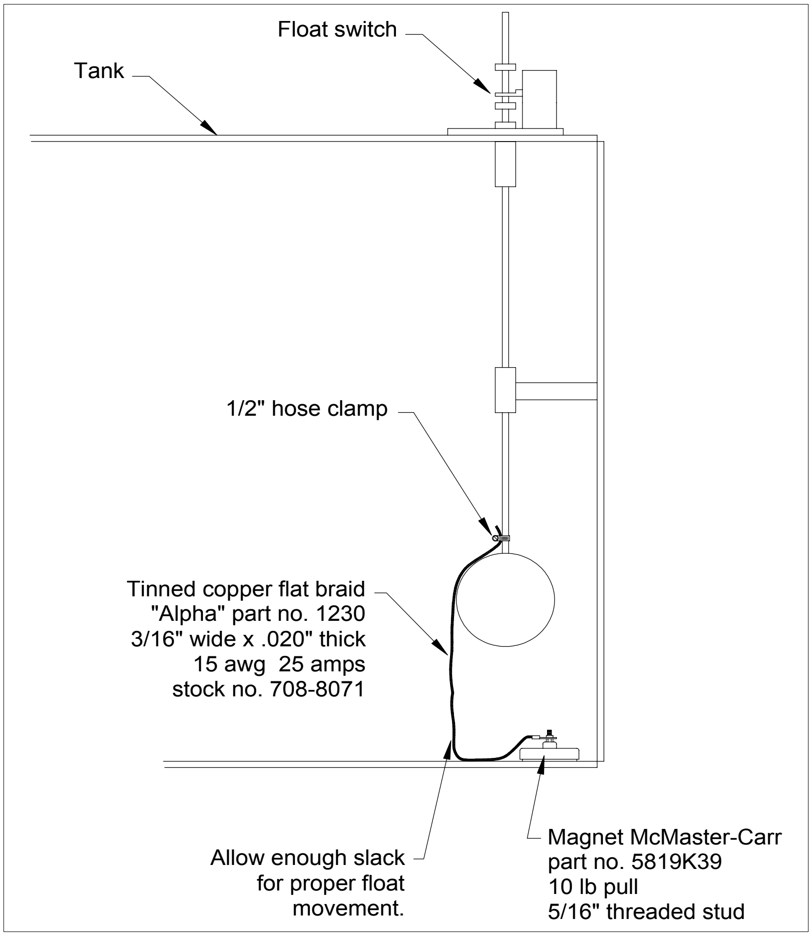

Figure 5 - Bonding of Conductive Objects

Bibliography

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5. Graham Hearn, "Coping with Electrostatic Hazards," Chemical Engineering, 11-91, pp. 188-193.
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