

## FLOW CONTROL ORIFICE

The D-12 and D-24 coarse bubble diffusers are designed to accept several different orifice size inserts inside the threaded nipple to control and balance air flows. The orifice is sized to create additional headloss so that air flows uniformly throughout the header system and air exits each diffuser at approximately the same air flow rate per diffuser.

Flowing gasses take the path of least resistance and flow to the lowest pressure. Header pressures are lowest near the dropleg as opposed to the farthest point from the dropleg because of the friction headloss in the header. Lower pressures can exist at other points in a diffuser/header system that is not properly leveled (varying static submergence). Without orifice flow control, air will flow through the header and exit at the diffusers closest to the dropleg and/or at diffusers that are higher than the common plane of the system (tilted or misleveled). Excess air will exit the lower pressure diffusers because the increased headloss in those diffusers equals the total remaining system headloss.

To prevent or minimize this undesirable situation, orifice flow control (additional headloss) is added at the diffuser. The individual orifice headloss at each diffuser should be at least 2.5 times greater than the header friction headloss and the minimum should be 2.5 inches water column (actual compressed conditions). This criterion will help ensure that the individual diffusers will control the airflow rate per diffuser rather than the relative position of the diffusers on the header.

The SANITAIRE Technical Data Sheet includes three curves of headloss versus air rate per diffuser. The curves are in terms of standard conditions (14.7 PSIA and 68°F). Compressed air for submerged aeration systems will usually have pressures and temperatures different than standard conditions. To determine the actual compressed headloss, the correction factor calculation shown on the Technical Data Sheet should be used.

For systems where air is routinely shut off to the coarse bubble equipment, the largest orifice size ( $\frac{3}{4}$ "  $\varnothing$ ) is preferred. An example would be aerobic digesters where decanting takes place. When air is shut off to the system, solids can enter the piping system. If this situation continues for long periods, solids can coagulate in the piping and become difficult to evacuate when the air returns to the system. Smaller orifice inserts may prevent these solids from being evacuated. High air rates per diffuser will aid in preventing plugging in the diffusers connectors and piping.

## FABRICATION CLEANING TECHNIQUES

### NECESSITY

The material used for the SANITAIRE header systems is L grade (extra low carbon) stainless steel. The choice of this material was dictated by the intent of providing the end user with an economical yet easy to maintain aeration system. Extra low carbon stainless steels were developed to protect welded products against corrosion in the heat-affected zones adjacent to the welds. The problem associated with "carbon precipitation" is overcome by the use of stainless steel types with low carbon content.

Stainless must be properly "passivated" or cleaned after fabrication to maintain its corrosion resistance. Stainless steel becomes resistant to corrosion when a naturally occurring chromium oxide film is allowed to form on its surface. For the film to occur, however, the stainless steel must be cleaned of all contaminants that may have been deposited during the fabrication procedure. (Oils, greases, weld burns, oxide scales, etc.) There are numerous methods available for cleaning the stainless including wire brushing, sandblasting or pickling baths. The contaminant and the particular product best dictate the selection.

### SANITAIRE APPROACH

Full immersion passivation is the cleaning method of choice for this type of equipment. The particular equipment design dictates this procedure because this is the only feasible method of cleaning the interior surfaces of the header pipe and connectors where welding zones exist. With a bath procedure, the entire assembly is dipped in a tank with a cleaning solution (usually hydrofluoric and nitric acids for treatment). These segments are usually fabricated in lengths up to 40 feet long making it impossible to clean the interior by other means. Where hand cleaning is proposed (spot passivation, wire brushing, etc.) this usually is only for exterior areas that are easily accessible. Since the inside is difficult to inspect, the lack of cleaning can easily go unnoticed by the jobsite inspector. It should be remembered that with this type of application, the interior surfaces are much more likely to corrode because they are constantly subjected to an environment of hot, moist air rich in oxygen.

## HEADER TO CONNECTOR WELD PROCEDURE

### NECESSITY

Provide an attachment method that is structurally sound and that limits potential for:

- Weld corrosion failure
- Plugging of passages with solids
- Increased system headloss

### SANITAIRE APPROACH

Sanitaire uses a full penetration butt type weld for attachment of the diffuser connector to the header. This methodology that is not proprietary and is common to many industries ensures a smooth, rounded internal flow zone for the attachment point. The critical connector weld is also free of internal niches that could result in the occurrence of crevice type corrosion.

Some manufacturers propose a fillet weld at this location since it is less expensive to produce. A fillet weld, however, results in both an internal crevice and a lipped, squared off entrance where solids can attach and build up. This build up can not only impact on the aeration system performance, it can also result in increased corrosion rates. On some applications, the build up of solids has resulted in localized areas of anoxic activity of the stainless steel product. These conditions can lead to the microbial formation of acids (sulfur reducing) that can severely attack the material. The fillet weld arrangement in particular for anoxic-oxic systems or aerobic digesters is not recommended.

## CONNECTOR END GUSSETING

### NECESSITY

The wide band system design uses cantilevered diffusers mounted to the invert (bottom) of the piping system to allow all liquid to be evacuated from the system during start-up. To provide reduced long-term maintenance costs, stainless steel material is used and smooth rounded entrance ports are die-formed for all diffuser connector points. (See Header to Connector Weld Procedure discussion). Die forming requires the use of thin gauge material, which also offers the advantage of lower capital cost for the end users. The particular equipment configuration can result in significant stress development in the area of the diffuser connector if not properly designed. These stresses result from a combination of dead and live ("vibration") type loadings that can cause weld fracture at the connector/header attachment point and/or deformation ("oil canning") of the header tube. With proper design and fabrication these stresses can be addressed.

### SANITAIRE APPROACH

As the original developer of these types of systems, Sanitaire has gained significant long-term performance experience with this equipment. The design arrangement necessitates the use of separate reinforcing gussets tying the connector ends to the sidewall of the header tube. This provides a rigid, reinforced weldment capable of withstanding the various fluctuating loads normally encountered. Note that the proper location for these gussets is not directly at the connector attachment location. Placement at this point, though less costly, adds little to the structural integrity of the connection. Some manufacturers generally furnish such gussets only for cosmetic purposes to achieve approval on specification submittals.

For dead load design purposes, a moment of 1000 inch pounds at the connector was used. This provides a safety factor of (3) on the basis of:

$$15 \text{ lb. load} \times 24'' \text{ diffuser} \times 3.0 \text{ SF} = 1080 \text{ in. lbs.}$$

The 15 lb. figure was derived from actual experience as the typical maximum amount of wet stringy material that might be expected to build up on a diffuser over a long period of time if proper plant screening procedures are not followed.

The long-term effects of the constant vibration transmitted from the diffuser body to the connector during normal operation are difficult to specifically quantify on all projects. Based on in-house testing and field experience, the end type of gusseting has provided substantially better long-term service than earlier non-gusseted designs.

