# Scrubbed Horizontal Transfers – How it Works

By Clive Hadfield

Scrubbing to remove gases or vapours from other gases depends on the physics and chemistry of the absorbents or reactants. It also depends on the essential scrubbing mechanism for sufficient area, time and turbulence. There are well known technical and economic shortfalls in current mechanisms. Well proven horizontal plates which address all the three problems and several secondary problems, will be described. A proving column has been tested to "standard" and witnessed! Witnessed results and the numerate capabilities of the device are available. The measured characteristics of the described device may have particular advantages for $CO_2$ absorption.

Gas "scrubbing" technology has been in use for well over a century. Early examples include the purification of coal gas and the wet washing of iron foundry cupola exhausts.

The essence of "scrubbing" is the transfer of a material from a gas stream to a liquid stream, so that the gas stream is "cleaned". Usually, one of the streams is continuous, e.g. bubbles of gas pass upward via a continuous layer of liquid or droplets of liquid fall down via a continuous up flowing gas stream. The surface area of the interface between gas and liquid is important. The material to be transferred from gas to liquid must pass through this surface. Therefore, the larger the total interface surface area (the bubbles or the droplets) the better the rate of transfer.

Most current systems operate in a vertical mode. The gas flows up and the liquid flows down. This means that the length of contact time any bubble, film or droplet is relatively short. The longer the contact time, the better is transfer from gas to liquid.

Turbulence at the interface of bubbles, films or droplets promotes vigorous transfer. Unfortunately, most current mass transfer devices are not genuine "scrubbers" (i.e. there is no significant energy input at the interface to promote high Reynolds numbers). Rather most "scrubbers" are actually "contactors", allowing a relatively gentle brief contact between gas and liquid.

These constraints mean that:

- For dumped packings, the apparatus is necessarily large in order to provide adequate surface and time for gas to liquid contact. Unfortunately, this very largeness leads to liquid maldistribution and loss of contact as liquid paths downward miss up coming paths in a phenomenon known as "channelling".
- For plate columns, large liquid hold ups, with associated pumping and back pressure problems, are necessary in order to provide sufficient time for transfer from gas to liquid.
- For structural packings and falling films, high fanning rates may be necessary to promote sufficient at the liquid surfaces.

Successful absorption, depends upon two essential factors:

i. The efficacy of the liquid absorbent, in combination with the particular operating conditions (concentration, temperature, etc) and
ii. The mechanics of mass transfer.

This brief note is about the mechanics of mass transfer between gases and liquids.

## Scrubbed Horizontal Film Transfer

In the late 1960's, a device to overcome most of these problems was developed. It was known as the film tray. Over two hundred columns were packed with film trays, worldwide. Scrubbed horizontal film technologies (including film trays) work by using some of the kinetic energy of an up flowing gas stream to evenly form and distribute a series of thin horizontal films of a step wise descending absorbent liquid. By effecting the transfer on a series of closely spaced horizontal plates, a large surface area is presented, and the thin liquid film is vigorously scrubbed by the high velocity gas stream. The counter flowing horizontal gas stream, together with the near absence of gravity induced flow by the relatively low volume liquid on the horizontal plate, allow sufficient time for mass transfer in approach equilibrium limits.

Transfer on SHF plates offers large surface areas, long contact time and surface scrubbing because of kinetic energy effects.

Inherent within the technology, are particular benefits:

- The avoidance of by passing and channelling, because of the self-distributing aerodynamics.
- High tolerance of fouling, which does not change the simple shape of the structure.
- Very low pack heights (HTS) because of the efficiency of mass transfer
- Wide operating range (Turndown) because of the non-critical relationship between liquid and gas flow rates.