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Guidelines for side-entering stock agitators

Scope

This paper provides guidelines for pulp, paper, and allied industry personnel for a better understanding of the process and mechanical information requirements for sizing and selection of side entering paper stock agitators. It supplies an overview as to the degree of impact this information has on the proper selection procedure. It is not the intent of this paper to supply specific agitator sizing information.

Safety precautions

No safety precautions apply.

Content

Side entering vs. top entering

Several differences must be considered when selecting side entering agitators versus top entering agitators. Some of the major points are listed in Table 1.

Table 1. Side vs. top entry agitation

Chest geometry	Side entry	Top entry
Application	Recommended for zone agitation or when agitation level is no more than 100% of the tank diameter or width. Broke or Pulper Dump when the liquid level is variable Couch pit and Press pit when used in conjunction with extractor plates with wiper blades No limit on applicability.	Good for tall vessels with operating level to diameter ratio greater than 1. Not applicable to high density chests. Higher Capital cost but lower in Horsepower. Rule of thumb is 1/3 hp but 3X capital cost Better for uniform consistency Better for low residence time consistency control applications Better for applications where side entry mechanical seal is not desirable or feasible.
Capital cost	Lower	Higher
Maintenance	Higher	Lower
Horsepower	Higher	Lower
Shaft sealing	Device required	Usually not required
Location	Proper wall location required.	Proper roof design to support agitator loads with space above required for removal clearance.

TIP Category: Automatically Periodically Reviewed (Ten-year review)



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Side entering agitation

Objective of agitation

The purpose of agitation is either a storage or blending function. Storage is a holding vessel usually regarded as a “large bulge in the pipeline” where minimum stock motion is required, whereas a blending vessel must have sufficient agitation to mix two or more streams of stock and water.

Types of agitation

Complete motion is defined as the degree of agitation providing noticeable movement of stock at the fluid surface sufficient to prevent stock dewatering and to equalize minor fluctuations in inlet consistency to $\pm 0.25\%$ bone dry as measured at pump suction. This level of agitation satisfies the requirements of the majority of stock chest applications. Typical applications include low density storage, pulper dump, rejects/accepts and white water chests.

Complete uniformity is a higher degree of mixing than “complete motion.” It is typically used in blending and dilution applications. Influent streams can vary in consistency, freeness, or furnish type. In this case, the agitator is required to even out consistency and freeness to produce a blended furnish to within $\pm 0.1\%$ bone dry as measured at pump suction. Agitation is dependent on stock rheology, chest geometry, volume, the difference in influent streams, and residence time within the agitation zone. Blending is defined as sufficient agitation to mix or blend two or more streams of stock and water. Solids suspension is a necessity in stock blending. Applications include blend, machine, latency, screen feed and refiner feed chests.

Zone agitation is the degree of agitation providing complete stock motion of the entire bottom of the chest sufficient to provide a reasonably uniform pump effluent without the need to agitate the entire chest. Bottom zone agitation is used when complete motion is not necessary or impossible to achieve. Typical applications include blow tanks, broke storage, dump chests, bleach towers, and high density storage towers that require only bottom zone agitation and loose output stock uniformity. These chests involve dilution operations, which often require a stated throughput in bone dry tons per day or liters (gallons) per minute of both the in and out flow streams, and capacity of the zone being diluted.

Tank/chest design

Configurations for stock chests include:

- Circular chest with a height to diameter ratio of 1 to 1 and an operating level of 75% to 80%.
- Square chest with a height to side wall ratio of 1 to 1 and an operating level of 75% to 80%.
- Rectangular chest for one or more agitators.

Midfeathers were included in the early “race-track” circulator designs. These are no longer built. A circulator impeller pushes or pulls, pumping stock at 4% bone dry consistency or less through circular opening(s) in a midfeather wall. No mixing takes place. A midfeather chest is only a storage vessel. New agitators can be installed with significant modifications to or elimination of interior walls to provide some mixing.

High density storage chests can be a straight cylindrical design or have a reduced diameter lower section. In both designs the agitation is confined to the lower portion of the tank. The agitated zone height to agitation zone diameter range is 0.5 to 0.8.

Floor slopes and fillets fillets are recommended when the residence time to perform a task is more than adequate at a given throughput. They are designed to take up excess volume and reduce possible dead zones so that energy to achieve adequate mixing is minimized. In a regular stock chest, a floor slope of 21 to 42 mm/m (0.25 to 0.50 in. per foot) of floor toward the pump suction should be sufficient to ensure proper drainage.

Housekeeping fillets of 30.5 cm (12 in.) at 45 degrees should be used in all corners to prevent stock from hanging up. For zone agitation generally a 45 or 60 degree fillet with a 180 degree wrap is acceptable to reduce the volume in

the zone only if there is at least 10 to 15 minutes of residence time. (Consult agitator supplier for fillet design requirements)

Agitator location

Cylindrical chests containing stock at consistencies above 3% bone dry should have the agitator located on the vertical tank center line. For consistencies below 3%, the agitator should be offset one sixth the tank diameter to the left of centerline for agitators with clockwise rotation and to the right of center for counter clockwise, as viewed from the drive end of the agitator. Offset mounting is necessary to minimize the possibility of vortexing and potential for air entrainment. For consistency above 3% the stock has enough natural dampening effect so vortexing is avoided when the liquid level of the stock is at least 1.5 D above the impeller. For multiple agitators in a round chest, the agitators should be spaced 15-30 degrees apart pointing on a common point at the opposite wall.

Low consistency applications using multiple agitators should be avoided. See Figures 1, 2, and 3 (figures provided by SPX Flow, Lightnin Mixers) for suggested location of agitator, dilution inlet, recirculation, and pump suction outlet.

Legend for Figures 1, 2 and 3.

<u>Centerline</u>	<u>Description</u>
1	Chest (and fillet if used)
2	Agitator
3	Dilution, water
4	Recirculation
5	Pump Suction

Angle Size

A = 0 to 5°

B = 0 to 10°

C = 0 to 15°

D = 0 to 20°

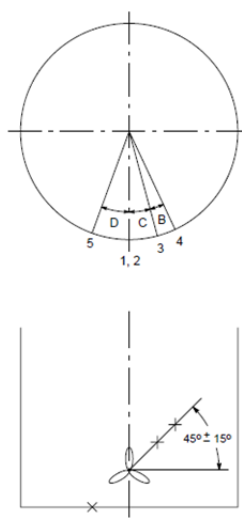


Fig. 1. One agitator per chest.

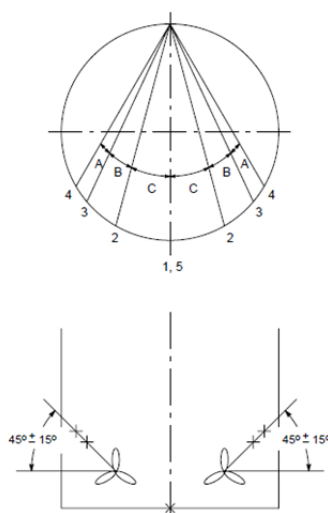


Fig. 2. Two agitators per chest, both operating

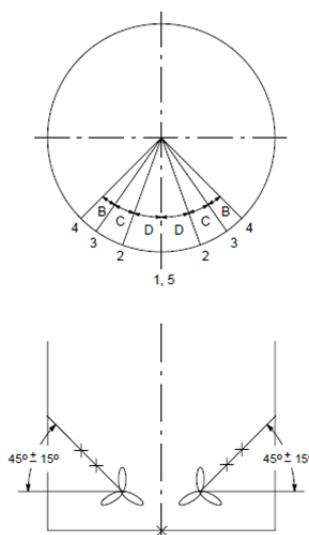


Fig. 3. Two agitators per chest, one operating, one spare.

Rectangular chests with a long rectangular design may have one agitator placed on the vertical center line of the short wall or multiple agitators placed on the long wall so that each agitator operates in the center of its area. For example, for a chest twice as long as it is wide the agitators would be placed on each quarter point of the long wall.

Agitator Impeller location should ideally be such that the agitator impeller tip is 23cm (9 in.) from the chest floor but no closer than 15 cm (6 in.), to prevent hydraulic backwash which can cause severe shaft deflection. The impeller should be mounted at a minimum of one half the impeller diameter off the inside chest wall.

Inlets should flow into the chest on the opposite half of the chest to the pump suction in the area of the highest surface velocity. The inlet streams should not fall on top of the agitator impeller.

Pump suction in cylindrical chests should be installed 0 to 30 degrees from the agitator center line.

Dilution lines into a chest with a single pump should be placed in the opposing half of the chest from the pump suction and no closer than 15 cm (6 in.) within the diameter of the agitator impeller. For a chest with dual pumps