ENG DESIGNS LLC
OPTIMIZING EFFICIENCY

Hydra Bubble
WICKED MIXING

THE PHYSICS OF TANK TURNOVER

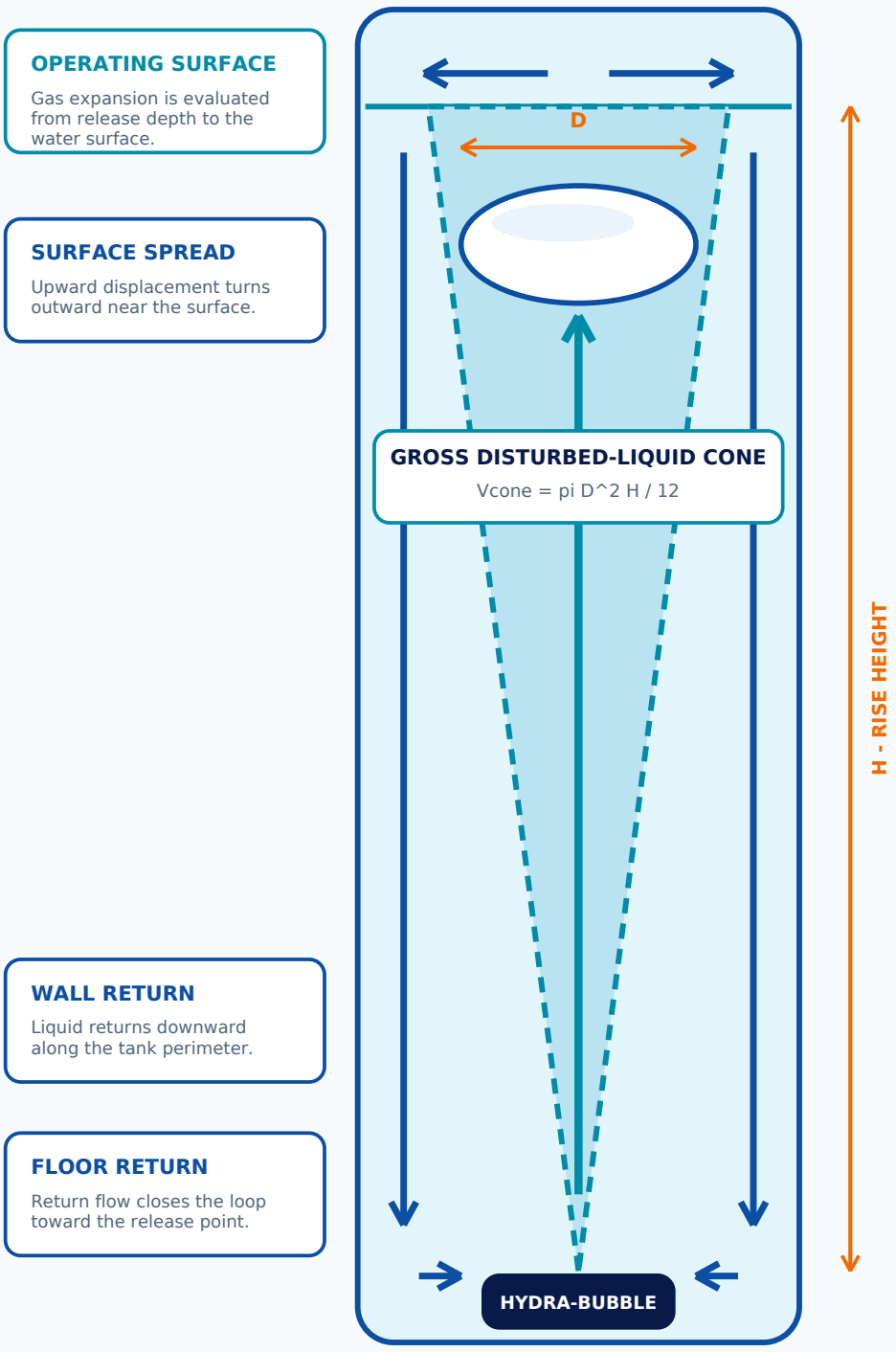
HOW BUBBLES PER MINUTE PER MIXER ESTABLISH WHOLE-TANK TURNOVER

ONE RELEASE EVENT > TOTAL BASIN EVENTS > SYSTEM CIRCULATION > TURNOVERS PER HOUR

1 ONE RELEASE EVENT

Expansion, spherical-cap geometry, and effective disturbed volume

HYDRAULIC-CYCLE AND CONE-DISPLACEMENT GEOMETRY



1 RELEASE-DEPTH PRESSURE

$$P0 = Patm + gamma\ H$$

Absolute pressure at the release point. H is the vertical rise distance to the operating surface.

2 SURFACE GAS VOLUME

$$Vs = V0\ (P0 / Patm)$$

First-order isothermal expansion from release conditions to the operating surface.

3 BUBBLE REFERENCE DIAMETERS

$$d = (6Vs / pi)^(1/3) \qquad D = d / 0.445$$

d is the volume-equivalent diameter. D is the characteristic spherical-cap lateral diameter.

4 GROSS DISTURBED-LIQUID VOLUME

$$Vcone = pi\ D^2\ H / 12$$

The cone extends from the release point to its modeled base at the operating surface.

5 ENG SLIP FACTOR

$$Cs = 0.875 \qquad Vevent,eff = Vcone\ Cs$$

ENG field-observation factor: effective event circulation is 87.5% of the idealized cone volume.

BUBBLES PER MINUTE ARE APPLIED TO EVERY ACTIVE MIXER IN THE BASIN

2 SYSTEM CIRCULATION AND TANK TURNOVER

BPM is bubbles per minute per mixer

6 TOTAL BASIN EVENTS

$$R = N \times BPM$$

R is total basin events/min. N is active mixers; BPM is the release rate per mixer.

7 SYSTEM CIRCULATION

$$Q = R \times Vevent,eff$$

Q is ft^3/min. Multiply total basin events by effective circulation volume per event.

8 TURNOVERS PER HOUR

$$TO = 60Q / Vtank$$

Tank volume and system circulation must use consistent volume units.

9 MINUTES PER TURNOVER

$$t = 60 / TO$$

The reciprocal converts turnovers/hour to minutes per tank turnover.

TURNOVER IS ESTABLISHED BY EVENT VOLUME, BPM PER MIXER, ACTIVE MIXER COUNT, AND TANK VOLUME.

THE EQUATION CHAIN KEEPS EACH INPUT VISIBLE AND TRACEABLE THROUGH THE FINAL RESULT.

Cs = 0.875 is identified by ENG Designs as a field-observation slip factor developed for this turnover framework.