

ภาวะที่มีผลต่อการผสมในถึงกวนแบบต่อเนื่อง



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Conditions Affecting Mixing  
in a Continuously Stirred Vessel



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KEY WORD: TURBULENT FLOW, CONTINUOUS STIRRED VESSEL, IMPELLER, MIXING, BAFFLE

TEERAYUT LORPUMPUN : CONDITIONS AFFECTING MIXING IN A CONTINUOUSLY STIRRED VESSEL, THESIS ADVISOR : ASST.PROF. SASITHORN BOON-LONG, DR.3IEME CYCLE, THESIS CO-ADVISOR: DR. JIRDSAK TSCHEIKUNA, PH.D. 161 PP.ISBN 974-584-170-6

The conditions affecting mixing in continuous stirred vessel was studied in standard configuration tank having inside diameter 20, 25 and 30 cm. respectively, filled with water to a height equal to the tank diameter. The feed entered at the impeller level and exited at the liquid level. Conductivity detectors were installed at the impeller level and at the exit.

The conditions affecting the mixing system were studied, the major parameters were: types of impeller (a six bladed open turbine, a six bladed disc turbine and a six bladed 45° pitch turbine), rotation speed of impeller (264.87 to 618.27 rpm.), position of the impeller (at 1/2 and 1/3 tank's diameter above tank's bottom), diameter of the impeller, direction of the six bladed 45° pitch turbine rotation, tank diameter (20, 25, 30 cm.) and the mean residence time (30, 55, 90, 125 min.).

From the results, the six bladed disc turbine at 1/3 tank's diameter above tank's bottom gave shorter residence time and mixing time. High speed of rotation of the impeller gave longer residence time but shorter mixing time. The larger the tank, the longer was the residence time. The larger the impeller diameter the shorter was the mixing time and the residence time but disturbances occurred in the system. The direction of the the six bladed 45° pitch turbine that caused the current to flow up to the liquid surface gave longer residence time but shorter mixing time than in the opposite direction. High inlet flow rate gave shorter residence time and shorter mixing time.

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# พิมพ์ต้นฉบับบทคัดย่อวิทยานิพนธ์ภายในกรอบสี่เหลี่ยมนี้เพียงแผ่นเดียว

ธีรยุทธ หล่อภูมิพันธ์ : ภาวะที่มีผลต่อการผสมในถังกวนแบบต่อเนื่อง (CONDITIONS AFFECTING MIXING IN A CONTINUOUSLY STIRRED VESSEL) อ.ที่ปรึกษา : ผศ.ดร. ศศิธร บุญหลง, อ.ที่ปรึกษาร่วม: อ.ดร.เจตศักดิ์ ไชยคุนา, 161 หน้า. ISBN 974-584-170-6




การศึกษาภาวะที่มีผลต่อการผสมในถังกวนแบบต่อเนื่องที่มีสัดส่วนมาตรฐานขนาดเส้นผ่านศูนย์กลางภายใน 20, 25 และ 30 ซม. ตามลำดับ และมีน้ำบรรจุอยู่สูงเท่ากับขนาดเส้นผ่านศูนย์กลางภายในถังแต่ละใบ โดยสภาวะที่ใช้ในการทดลองเป็นแบบต่อเนื่องที่มีการป้อนที่ตำแหน่งใบพัด และจุดออกที่ระดับความสูงของระดับน้ำ และติดตั้งจุดวัด 2 จุด คือ ที่ระดับใบพัดและที่จุดออก

ในงานวิจัยนี้ได้ทำการศึกษภาวะที่มีผลต่อการผสมในถังกวนแบบต่อเนื่องโดยเปรียบเทียบผลที่ได้จากการเปลี่ยนตัวแปรในการศึกษาคือ ชนิดของใบกวน ซึ่งเป็นใบกวนชนิดก้นแบนที่มีใบกวน 6 ใบ 3 ชนิด คือ แบบเปิด, แบบติดบนจาน และแบบใบพัดเอียง 45 องศา, ความเร็วรอบของการกวน ในช่วง 264.87-618.27 รอบต่อนาที ตำแหน่งของใบพัดกวนที่ระยะความสูงจากก้นถัง 1/2 และ 1/3 ของเส้นผ่านศูนย์กลางภายในของถัง ขนาดของถัง ทิศทางการหมุนของใบพัดเอียง 45 องศา อัตราการป้อนสาร และนอกจากนี้ยังได้ทำการทดลองศึกษาผลของขนาดเส้นผ่านศูนย์กลางของใบพัดที่มีผลต่อระบบ โดยการวิเคราะห์แบ่งเป็น 2 ส่วนคือ เวลาที่สารอยู่ภายในถัง และเวลาที่ระบบเป็นเนื้อเดียวกัน

จากการศึกษาพบว่า ใบกวน 6 ใบแบบติดบนจานที่ตำแหน่งความสูงจากก้นถัง 1/3 ของเส้นผ่านศูนย์กลางภายในของถังจะให้ค่าเวลาที่สารอยู่ภายในถังและเวลาที่สารเป็นเนื้อเดียวกันที่สั้นที่สุด สำหรับถังใบใหญ่จะให้เวลาที่สารอยู่ภายในถังนานกว่าถังใบเล็ก โดยความเร็วรอบของใบพัดที่สูงจะให้ค่าเวลาที่สารอยู่ภายในถังนานแต่เวลาในการผสมสั้นกว่าถังใบเล็ก ในระบบที่ใช้ใบพัดขนาดใหญ่กว่ามาตรฐานจะให้ค่าเวลาที่สารอยู่ภายในถังและเวลาที่สารเป็นเนื้อเดียวกันเร็วกว่าใบพัดมาตรฐานแต่จะเกิดความปั่นป่วนสูงกว่าทำให้ควบคุมยากกว่าระบบที่ใช้ใบพัดขนาดมาตรฐาน ทิศทางการหมุนของใบพัดเอียง 45 องศาในทิศที่ก่อให้เกิดกระแสขึ้นไปที่มีผิวหน้าของเหลวจะให้ค่าเวลาที่สารอยู่ภายในถังนานกว่า แต่เวลาที่ระบบเป็นเนื้อเดียวกันสั้นกว่าทิศทางตรงกันข้ามและอัตราการไหลเข้าที่เร็วกว่าจะให้เวลาที่สารอยู่ภายในถังนานแต่เวลาในการผสมสั้นกว่าอัตราการไหลเข้าที่ช้ากว่า

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จุฬาลงกรณ์มหาวิทยาลัย

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สาขาวิชา .....วิศวกรรมเคมี.....  
ปีการศึกษา ..... 2536.....

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ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

## Nomenclature

$A$	Cross sectional area of the conducted matter.	(cm. <sup>2</sup> )
$B$	Baffle size	(cm.)
$C$	Diameter of the impeller	(cm.)
$d$	Impeller diameter	(mm.)
$D$	Inside pipe diameter	(in.)
$D_i$	Impeller diameter	(cm.)
$D_T$	Tank diameter	(in.)
$E$	Electromotive force	(V)
$H$	Velocity head	(cm./s)
$H_i$	Impeller height from the tank bottom	(cm.)
$H_l$	Liquid height	(cm.)
$I$	Electrical current	(A)
$k$	Conductivity	(Siemen/cm.)
$l$	Length of the conducted matter	(cm.)
$L$	Conductance	(mho)
$N$	Rotational speed of the impeller	(rpm.)
$N_p$	Power number	(-)
$N_{Re}$	Reynolds number	(-)
$N_{qd}$	Discharge flow rate number	(-)
$P$	Impeller power input	(Hp)
$q$	Impeller blade width.	(cm.)
$q_d$	Discharge flow rate	(cm. <sup>3</sup> /s)
$q_F$	Feed flow rate	(cm. <sup>3</sup> /s)
$q_l$	Internal flow rate	(cm. <sup>3</sup> /s)
$Q$	Flow rate or pumping capacity	(cm. <sup>3</sup> /s)
$Q$	Amount of Tracer	(cm. <sup>3</sup> )



### Nomenclature (continued)

$r$	Impeller blade length	(cm.)
$R$	Scale Ratio	(-)
$R$	Resistance	(ohm)
$Re_k$	Eddy Reynolds number	(-)
$s$	Length of impeller blade mounted on the central disc	(cm.)
$\bar{t}$	Mean residence time	(s)
$T$	Tank diameter	(cm.)
$v_k$	Velocity scale	(-)
$v$	Volumetric flow rate	(cm. <sup>3</sup> /s)
$v$	Fluid velocity	(m/s)
$V$	Volume of the system	(cm. <sup>3</sup> )
$W_b$	Baffle width	(cm.)
$Z$	Liquid height	(cm.)
$\epsilon_T$	Local energy dissipation rate/unit mass	(-)
$\lambda_k$	Eddy size	(-)
$\mu_0$	Fluid viscosity	(Pa sec)
$\mu$	Fluid viscosity	(cP)
$\theta$	Cell constant	(-)
$\theta_M$	Mixing time	(s)
$\rho$	Density of the fluid	(g/cm. <sup>3</sup> )
$\rho_{Resis}$	Specific resistance or resistivity	(Ohm-cm.)
$\tau$	Residence Time	(s)
$\nu$	Kinematic viscosity	(cm. <sup>2</sup> /s)
subscript 1, 2	Initial and final condition of scale-up method	(-)