Supporting Information

Table 1 Design equations for stream flow rates in hybrid systems

Design A	**Design B**
$D_1 = \frac{(x_F - x_{B1})}{(x_{D1} - x_{B1})}\left(1 + \frac{(x_P - x_{B1})}{(x_R - x_{B1})}\frac{(x_{D1} - x_R)}{(x_P - x_{D1})}\right)F$	$D_1 = \frac{(x_{B2} - x_P)}{(x_{D1} - x_P)}\frac{(x_F - x_{B1})}{(x_{B2} - x_{B1})}F$
$B_1 = \frac{(x_F - x_R)}{(x_{B1} - x_R)}F$	$B_1 = \frac{(x_F - x_{B2})}{(x_{B1} - x_{B2})}F$
$P = \frac{(x_{D1} - x_R)}{(x_P - x_{D1})}\frac{(x_F - x_{B1})}{(x_R - x_{B1})}F$	$P = \frac{(x_{D1} - x_{B2})}{(x_P - x_{D1})}\frac{(x_F - x_{B1})}{(x_{B2} - x_{B1})}F$
$R = \frac{(x_F - x_{B1})}{(x_R - x_{B1})}F$	$R = \frac{(x_F - x_{B1})}{(x_{B2} - x_{B1})}\frac{(x_{B2} - x_{D2})}{(x_R - x_{D2})}F$
	$F_{PV} = \left(\frac{(x_{B2} - x_P)}{(x_{D1} - x_P)} + \frac{(x_R - x_{B2})}{(x_{D2} - x_R)}\right)\frac{(x_F - x_{B1})}{(x_{B2} - x_{B1})}F$
	$D_2 = \frac{(x_R - x_{B2})}{(x_{D2} - x_R)}\frac{(x_F - x_{B1})}{(x_{B2} - x_{B1})}F$
	$B_2 = \frac{(x_F - x_{B1})}{(x_{B2} - x_{B1})}F$

Table 2 Cost summary for designs with local recycle.

		Design of Ethanol-Water with local Recycle		Design of IPA-Water with local Recycle	
		Capital cost	**Operating cost**	**Capital cost**	**Operating cost**
Distillation I		**1000 $ / y**	**1000 $ / y**	**1000 $ / y**	**1000 $ / y**
	Shell	37.866		10.153	
	Tray	5.530		1.010	
	Reboiler	22.400		12.547	
	Condensor	20.053		14.660	
	Steam		430.731		201.135
	Cooling water		10.886		7.039
	Total	**85.849**	**441.617**	**38.372**	**208.174**
Pervaporation					
	Membrane	77.5		51.189	
	Module	78.177		59.048	
	Replacement		259.461		183.727
	Inter heater	5.771		10.943	
	steam		32.457		85.949
	Feed Pump	0.110	0.0007	0.180	0.0012
	Vaccum	1.686	2.615	2.818	6.651
	Condensor	5.703	1.182	10.314	3.001
	recycle Pumps	0.296	0.005	1.693	0.024
	Total	**169.243**	**295.720**	**136.185**	**279.354**
Distillation II					
	Shell			37.897	
	Tray			5.424	
	Reboiler			11.154	
	Condensor			14.618	
	Steam				215.035
	Cooling water				7.110
	Total			**69.093**	**222.145**
TAC			**992.43**		**953.32**