components, membrane life and net flux (Fig. 2-13), based on the listed parameter values and Equation (13), indicates the sensitivity of OPEX to these two parameters. The doubling of the membrane life decreases the OPEX by 20-30% in this case, whereas doubling the flux decreases it by 30-38%. There is obviously greater sensitivity to membrane life at lower fluxes since the amount of water treated over the same time period decreases. Finally, sensitivity to membrane operational factors, and in particular SAD_p, increases with decreasing organic loading since the membrane aeration makes up a greater proportion of the total energy demand if the process aeration is decreased.

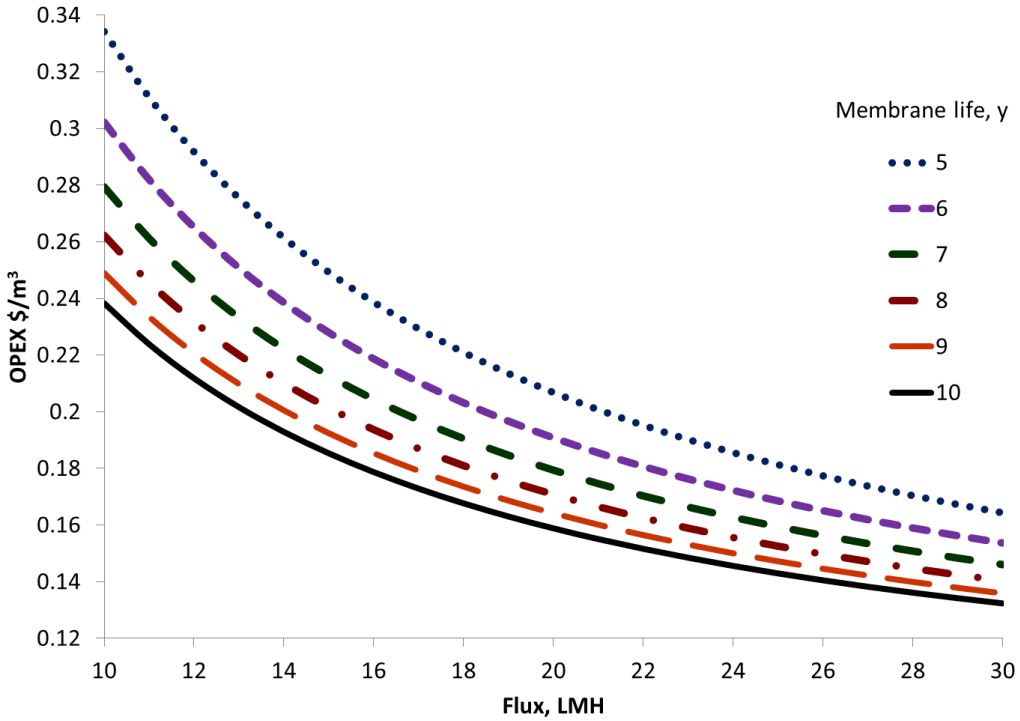

Figure 2-13 OPEX as a function of net flux and membrane life (excl. labour and waste disposal costs)

Table 2-2 Base parameter values for OPEX determination

Parameter	Symbol	Units	Value
COD removed	ΔS_{COD}	mg/L	1,000
TKN removed	ΔS_{TKN}	mg/L	50
Specific aeration demand against membrane area[1]	SAD_m	Nm³/(m².h)	0.25
Specific energy demand for permeation	$E_{L,m}$	kWh/m³	0.015
Energy demand of sludge pumping (power/sludge flow)	$E_{L,sludge}$	kWh/m³	0.02
Specific energy demand of process aeration[2]	$E_{L,bio}$	kWh/m³	0.5
Energy demand of blower (power/air flow delivered)[2]	E'_A	kWh/Nm³	0.021
Recycle ratio: membrane-biotank + between biotanks	R	-	4
Electrical energy cost	L_E	$/kWh	0.12
Membrane cost	L_M	$/m²	80
Chemicals cost, 10-15% hypo and 50% citric[3]	L_C	$/m³	0.008

[1]*Usually recommended by the technology supplier*
[2]*See Annex 1 for full calculation*
[3]*Reagents priced at $1,800/te 10-15% hypo and $860/te citric*

2.7.3 Total cost

Total expenditure (TOTEX), the combination of CAPEX and OPEX, can be represented by the net present value (NPV):