TITLE: Heat of Dissolution Measurements for CO_2 in Mixed Alkanolamine Solvents

REPORT TYPE: Semi-Annual Technical Report

REPORTING PERIOD: 4/1/2005 to 9/30/2005

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DATE: December 1, 2005

DOE AWARD NUMBER: DE-FG26-03NT41912

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ABSTRACT

The main objective of this project is to measure heat of dissolution of CO_2 in carefully selected mixed alkanolamine solvent systems, and provide such directly measured data that might be used for efficient design of CO_2 capture processes, or for better understanding of thermodynamics of CO_2- alkanolamine systems. Carbon dioxide is one of the major greenhouse gases, and the need for stabilization of its composition in earth's atmosphere is vital for the future of mankind. Although technologies are available for capture and storage of CO_2, these technologies are far too expensive for economical commercialization. Reduction of cost would require research for refinement of the technology. For more economical CO_2 capture and regeneration, there is a need for development of more efficient solvent systems. In this project we will extend the thermodynamic database by measuring heat of solution data of CO_2 in mixed solvents made of MEA (monoethanolamine), MDEA (methyldiethanolamine), piperazine, and water. Mixed solvents of different compositions will be selected and in each case data will be measured at temperatures 40 and 80C and various partial pressures of CO_2. At the end of the project, observations, conclusions, and recommendations will be derived for the choice of mixed solvents for efficient CO_2 capture with potential for commercialization.

EXECUTIVE SUMMARY

The main objective of this project is to measure heat of dissolution of CO_2 in carefully selected mixed alkanolamine solvent systems, and provide such directly measured data that might be used for efficient design of CO_2 capture processes, or for better understanding of thermodynamics of CO_2- alkanolamine systems. Carbon dioxide is one of the major greenhouse gases, and the need for stabilization of its composition in earth's atmosphere is vital for the future of mankind. Although technologies are available for capture and storage of CO_2, these technologies are far too expensive for economical commercialization. Reduction of cost would require research for refinement of the technology. For more economical CO_2 capture and regeneration, there is a need for development of more efficient solvent systems. In this project we will extend the thermodynamic database by measuring heat of solution data of CO_2 in mixed solvents made of MEA (monoethanolamine), MDEA (methyldiethanolamine), piperazine, and water. Mixed solvents of different compositions will be selected and in each case data will be measured at temperatures 15, 40 and 80C and various partial pressures of CO_2. At the end of the project, observations, conclusions, and recommendations will be derived for the choice of mixed solvents for efficient CO_2 capture with potential for commercialization.

During the current period of performance, April 2005 to September 2005, heat of dissolution data measurements for CO_2 in aqueous MEA and MDEA solvents were completed. Data were measured for three solvent concentrations and at three temperatures, 15^oC, 40^oC and 75^oC. Data have also been measured for mixed solvents (MEA + MDEA) at three relative compositions and at the same three temperatures. Investigations are in progress to identify an additive that will further enhance the properties of the mixed solvents for CO_2 capture.

Some efforts have been made to develop correlations for solubility, enthalpy and rate of absorption of CO_2 in aqueous MEA and MDEA solutions. The correlations will provide a convenient means to study the trends in solubilities and enthalpies with temperature, pressure, and concentration of aqueous solution. This will facilitate determination of desirable solvent properties for optimum design of the CO_2 capture processes.

In the next quarter, some additives will be identified and preliminary data will be measured to understand the effect of the additive on CO_2 solubility in the solvent. The intent is to find an additive that will give desirable solvent properties. Work will be continued on the correlations for solubility, enthalpy and rates of absorption and results will be presented in the next report.

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1. Introduction

Carbon dioxide is one of the major greenhouse gases, and the need for stabilization of its composition in earth's atmosphere is vital for the future of mankind. Although technologies are available for capture and storage of CO_2, these technologies are far too expensive for economical commercialization. Reduction of cost would require research for refinement of the technology. The idea of capturing CO_2 from the flue gas of power plants did not start with concern about the greenhouse effect. Rather, it gained attention as a possible economic source of CO_2 , especially for use in enhanced oil recovery operations where CO_2 is injected into oil reservoirs to increase the mobility of the oil and, therefore, the productivity of the reservoir. Several commercial CO_2 capture plants were constructed in the late 1970s and early 1980s in the US. The North American Chemical Plant in Trona, CA, which uses the carbonation of brine to produce CO_2 , started operation in 1978 and is still operating today. However, when the price of oil dropped in mid-1980s, the recovered CO_2 was too expensive for enhanced oil recovery operations and all of the other CO_2 capture plants were closed.

Historically, CO_2 capture processes have required significant amounts of energy, which reduces the power plant's net power output. For example, the output of a 500 MW (net) coal-fired power plant may be reduced to 400 MW (net) after CO_2 capture. This imposes an "energy penalty" of 20%. The energy penalties of current capture technologies range from about 30% for conventional coal to about 15% for advanced coal. It is desired that in the next decade these numbers be brought to 50% of their current values.

To date, all commercial CO_2 capture plants use processes based on chemical absorption with the monoethanolamine (MEA) solvent. MEA was developed over 60 years ago as a general, non-selective solvent to remove acid gases, such as CO_2 and H_2S, from natural gas streams. The process was modified to incorporate inhibitors to resist solvent degradation and equipment corrosion when applied to CO_2 capture from flue gas. Also, the solvent strength was kept relatively low, resulting in large equipment sizes and high regeneration energy requirements. The process allowed flue gas to contact an MEA solution in the absorber. The MEA selectively absorbed the CO_2 and was then sent to a stripper. In the stripper, the CO_2 –rich MEA solution was heated to release almost pure CO_2 . The lean MEA solution was then recycled to the absorber.

Other processes have been considered to capture CO_2 from the flue gas of a power plant, e.g., membrane separation, cryogenic fractionation, and adsorption using molecular sieves. These processes are even less efficient and more expensive than the chemical absorption. The reason can be attributed to the very low CO_2 partial pressure in the flue gas. Therefore, a high priority research need is to formulate new solvents that can significantly reduce the energy penalty associated with chemical absorption. The new solvents must increase the loading (amount of CO_2 dissolved per unit amount of solvent), and the rate of CO_2 dissolution while maintaining a low heat of solution, so as to minimize the energy requirements during the solvent regeneration.

For the processes based on the absorption of CO_2 by aqueous alkanolamines, the energy penalty or the cost of the process depends mostly on three factors: (1) the loading of CO_2 (moles of CO_2 absorbed per mole of amine), (2) the rate of CO_2 absorption, and (3) the energy requirement for the release of CO_2 in the stripper. For a number of solvents, detailed studies are available in the literature for the first two factors. Aqueous MEA solvents suffer from the limitation that CO_2 loading cannot exceed much higher than 0.5. An amine that is considered as a potential replacement for MEA is methyldiethanolamine (MDEA) because of the high loading of CO_2 (approaching 1) which is attributed to the stoichiometry of the reaction forming carbamate. However, the rate of CO_2 absorption by MDEA is too low for commercial applications. Mixed solvents containing MEA and MDEA, and diethanolamine (DEA) and MDEA in water seem to provide good solutions to give high absorption rates as well as CO_2 loading. Recently researchers have also started looking at other additives to aqueous MEA and MDEA mixtures to enhance solubility and rate of absorption of CO_2. These include sulfolane, N-methylpyrrolidone (NMP), and piperazine (PZ). Of these, piperazine seems to be the most effective in increasing the solubility of CO_2. The data available in the literature indicate that aqueous mixtures of MEA, MDEA and piperazine have potential to provide a solvent system superior to aqueous MEA solvent of the current commercial capture plants. However, a true determination of this is difficult without a detailed study of the relative energy requirements for each of the solvents. Such a study is not available in the literature, mostly because of lack of experimental data on the heats of dissolution of CO_2 in the aqueous alkanolamine solvents. Data are available only for a few systems and at limited conditions.

For more economical CO_2 capture and regeneration, there is a need for development of more efficient solvent systems. In this project we will extend the thermodynamic database by measuring heat of solution data of CO_2 in mixed solvents made of MEA (monoethanolamine), MDEA (methyldiethanolamine), piperazine, and water. Mixed solvents of different compositions will be selected and in each case data will be measured at a few temperatures and at different concentrations of the aqueous solutions. At the end of the project, observations, conclusions, and recommendations will be derived for the choice of mixed solvents for efficient CO_2 capture with potential for commercialization.

2. Progress of Experimental Measurements

The experimental apparatus and the procedure for measurements were described in the previous reports. Data for solubility and enthalpy of CO_2 in aqueous MEA and MDEA solvents of different concentrations were also reported. Upon further analysis, the accuracy and reproducibility of the data were found to be unsatisfactory. It was determined that the flow rates of the solvent (0.1 to 1 ml/min) and the gas (1 to 12 SCCM) were too large for equilibrium to be attained in the calorimetric cells which have a measurement zone of approximately 1.4 ml volume. All the measurements were repeated with much lower flow rates of the solvent (0.02 to 0.2 ml/min) and gas (0.3 to 2 SCCM). The data showed much better accuracy and reproducibility. Data were measured at three temperatures 15^oC, 40^oC and 75^oC and for three solvent concentrations each for MDEA and MEA. Pressure was maintained at 100 psig by a back-pressure regulator. The results are shown in Figures 1 thru 18 and Tables 1 thru 18.

In each figure the heat evolved is plotted against CO_2 loading defined as moles of CO_2 per mole of amine. Two curves are shown, one for heat produced per mole of CO_2 and the other for per mole of amine. An observation of the heat of solution curves indicates that the heat of solution per mole of CO_2 is fairly constant with CO_2 loading at low CO_2 concentrations, but it decreases closer to the saturation concentration. Attempts are being made to model this behavior, and obtain expressions for heats of mixing as function of CO_2 concentration. Figures 1 thru 18 give saturation loading of CO_2 in addition to the heats of solution. Although, in most cases literature values are not available at the exact conditions of our experiments, our data are consistent with the interpolated saturation loadings obtained from the literature data. Figures 19 and 20 show the trends in the solubility data with solvent concentration and temperature as parameters.

Data have also been measured for CO_2 in mixed MEA+MDEA solvents of three different compositions each at the same three temperatures. The three solvent concentrations used are: MEA + MDEA weight % of (24+6), (18+12), and (6+24). The results are shown in Figures 21 thru 29 and Tables 19 thru 27. Results for solubilities and enthalpies show values in between the ones to be expected for the single amine solvents, and our data compare well with the limited data available in the literature. A paper presenting the data measured in this project is currently under preparation.

3. Conclusions and Plans for the Next Quarter

Some efforts have been made to develop correlations for solubility, enthalpy and rate of absorption of CO_2 in aqueous MEA and MDEA solutions. The correlations will provide a convenient means to study the trends in solubilities and enthalpies with temperature, pressure, and concentration of aqueous solution. This will facilitate determination of desirable solvent properties for optimum design of the CO_2 capture processes.

The original proposal included measurements using piperazine as an additional component. However, a critical study of the literature indicates that piperazine would not provide significant enhancement in the desirable solvent properties. The desirable solvent properties are: high CO_2 solubility which is true for MEA, MDEA and piperazine, high rate of absorption which is provided by MEA and piperazine (justifying the use of mixtures of MDEA with MEA or piperazine), and large drop in CO_2 solubility with temperature such that the CO_2 capture process could be operated with absorption and regeneration temperatures ranging from 25^oC to 75^oC as compared to 25^oC to 120^oC as required for aqueous MEA and MDEA and piperazine solvents. It is our intent to attempt to identify an additive to the aqueous MDEA+MEA solvent that will provide this desirable property. Some preliminary data measurements have been initiated using fluorinated inorganic compounds as additives, the motivation for this being that the fluorinated compounds have high affinity for CO_2.

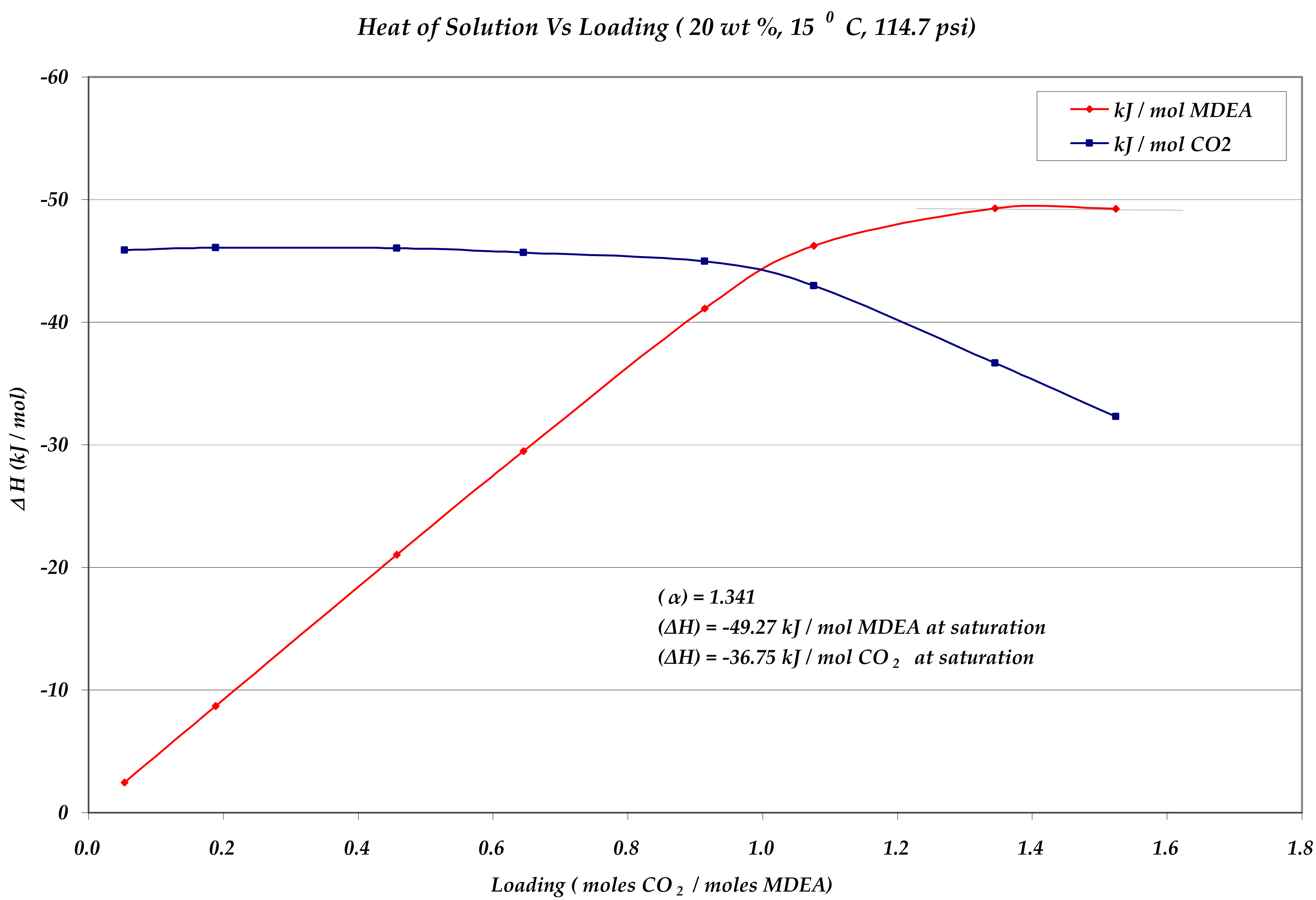

Figure 1: Enthalpy v/s Loading of CO_2 in 20 wt% MDEA solution at 15^0C and system pressure of 114.7 psi

Table 1: 20 wt % MDEA, 114.7 psi , 15 ^{0} C

CO_2 Flow Rate SCCM	CO_2 Mol/sec	MDEA Flow Rate ml/min	MDEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy ΔH (Average) kJ / mol MDEA
0.30	2.2E-07	0.15	4.2E-06	0.054	-10.2	-45.89	-2.47
0.70	5.2E-07	0.10	2.8E-06	0.188	-24.0	-46.09	-8.68
1.70	1.3E-06	0.10	2.8E-06	0.457	-58.2	-46.02	-21.04
1.20	8.9E-07	0.05	1.4E-06	0.645	-40.8	-45.66	-29.47
1.70	1.3E-06	0.05	1.4E-06	0.914	-56.9	-44.95	-41.10
1.20	8.9E-07	0.03	8.3E-07	1.076	-38.4	-42.96	-46.21
1.50	1.1E-06	0.03	8.3E-07	1.345	-40.9	-36.66	-49.30
1.70	1.3E-06	0.03	8.3E-07	1.524	-40.9	-32.31	-49.24

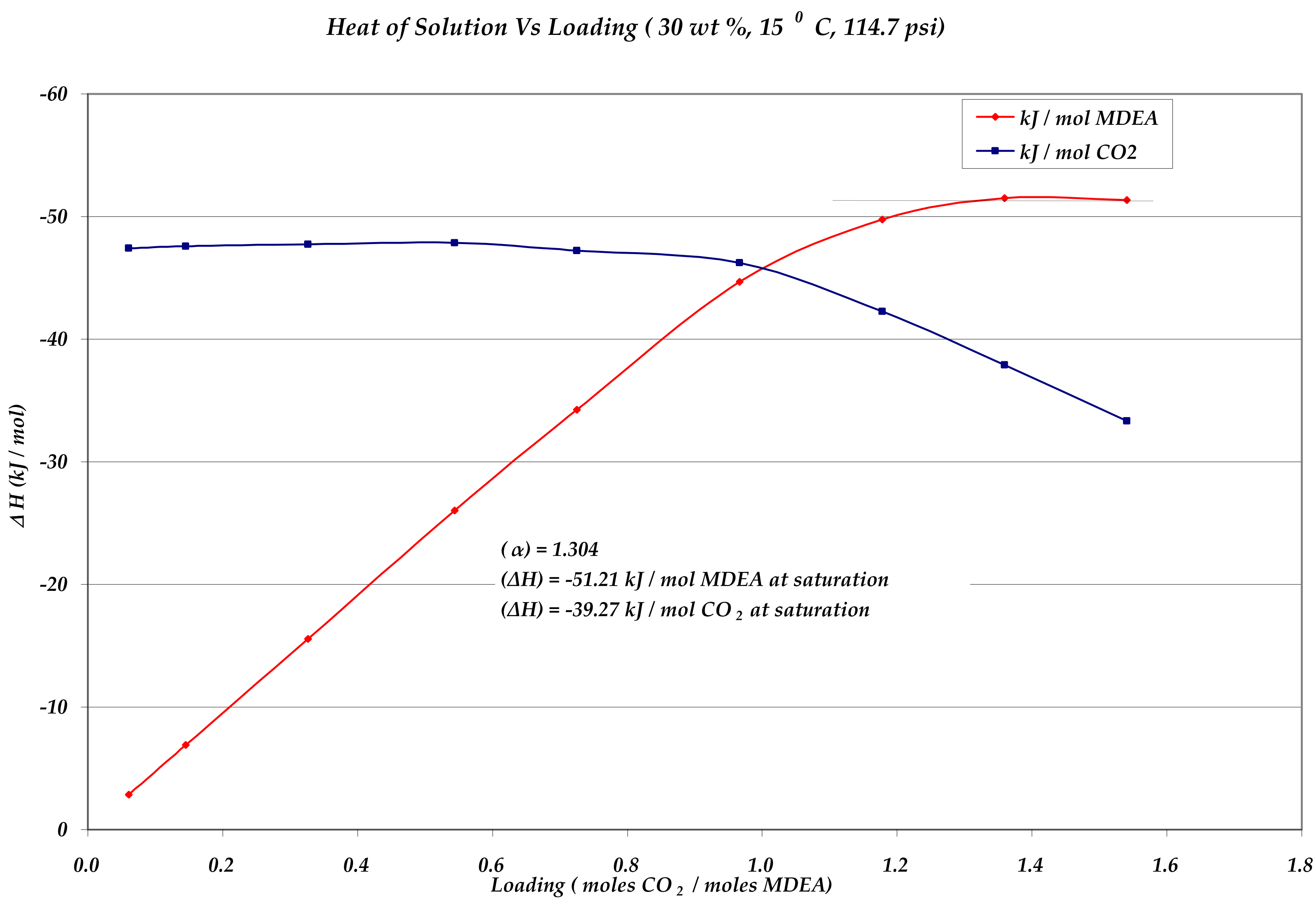

Figure 2: Enthalpy Vs Loading of CO_2 in 30 wt % MDEA solution at 15 ^{0} C and system pressure of 114.7 psi

Table 2: 30 wt % MDEA, 114.7 psi , 15 ^{0} C

CO_2 Flow Rate SCCM	*CO_2 Mol/sec*	*MDEA Flow Rate ml/min*	*MDEA Mol/sec*	*Loading of CO_2*	*Average Enthalpy mJ/sec*	*Enthalpy ΔH (Average) kJ / mol CO_2*	*Enthalpy ΔH (Average) kJ / mol MDEA*
0.50	3.7E-07	0.15	6.2E-06	0.060	-17.6	-47.44	-2.87
0.80	6.0E-07	0.10	4.1E-06	0.145	-28.3	-47.58	-6.90
1.80	1.3E-06	0.10	4.1E-06	0.326	-63.9	-47.72	-15.57
1.50	1.1E-06	0.05	2.1E-06	0.544	-53.4	-47.85	-26.02
1.20	8.9E-07	0.03	1.2E-06	0.725	-42.2	-47.24	-34.24
1.60	1.2E-06	0.03	1.2E-06	0.967	-55.0	-46.23	-44.68
1.30	9.7E-07	0.02	8.2E-07	1.178	-40.9	-42.25	-49.77
1.50	1.1E-06	0.02	8.2E-07	1.359	-42.3	-37.89	-51.49
1.70	1.3E-06	0.02	8.2E-07	1.540	-42.2	-33.33	-51.34

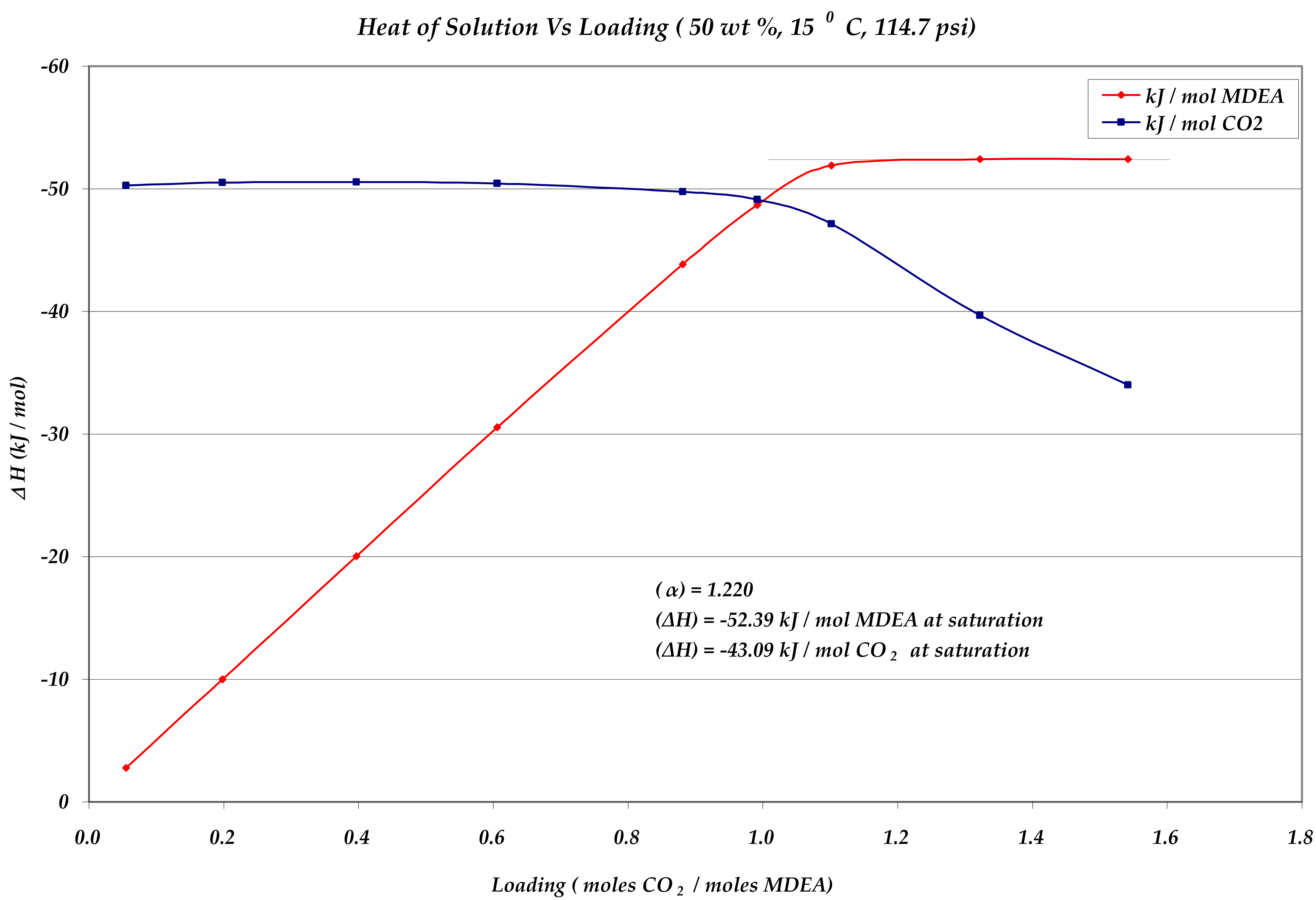

Figure 3: Enthalpy Vs Loading of CO_2 in 50 wt % MDEA solution at 15^0 C and system pressure of 114.7 psi

Table 3: 50 wt % MDEA, 114.7 psi , 15 ^{0} C

CO_2 Flow Rate SCCM	CO_2 Mol/sec	MDEA Flow Rate ml/min	MDEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy ΔH (Average) kJ / mol MDEA
0.50	3.7E-07	0.10	6.8E-06	0.055	-18.7	-50.28	-2.77
1.80	1.3E-06	0.10	6.8E-06	0.198	-67.6	-50.51	-10.02
1.80	1.3E-06	0.05	3.4E-06	0.397	-67.7	-50.58	-20.06
1.10	8.2E-07	0.02	1.4E-06	0.606	-41.3	-50.42	-30.55
1.60	1.2E-06	0.02	1.4E-06	0.881	-59.2	-49.75	-43.85
0.90	6.7E-07	0.01	6.8E-07	0.991	-32.9	-49.11	-48.69
1.00	7.4E-07	0.01	6.8E-07	1.102	-35.1	-47.13	-51.92
1.20	8.9E-07	0.01	6.8E-07	1.322	-35.4	-39.67	-52.44
1.40	1.0E-06	0.01	6.8E-07	1.542	-35.4	-33.99	-52.42

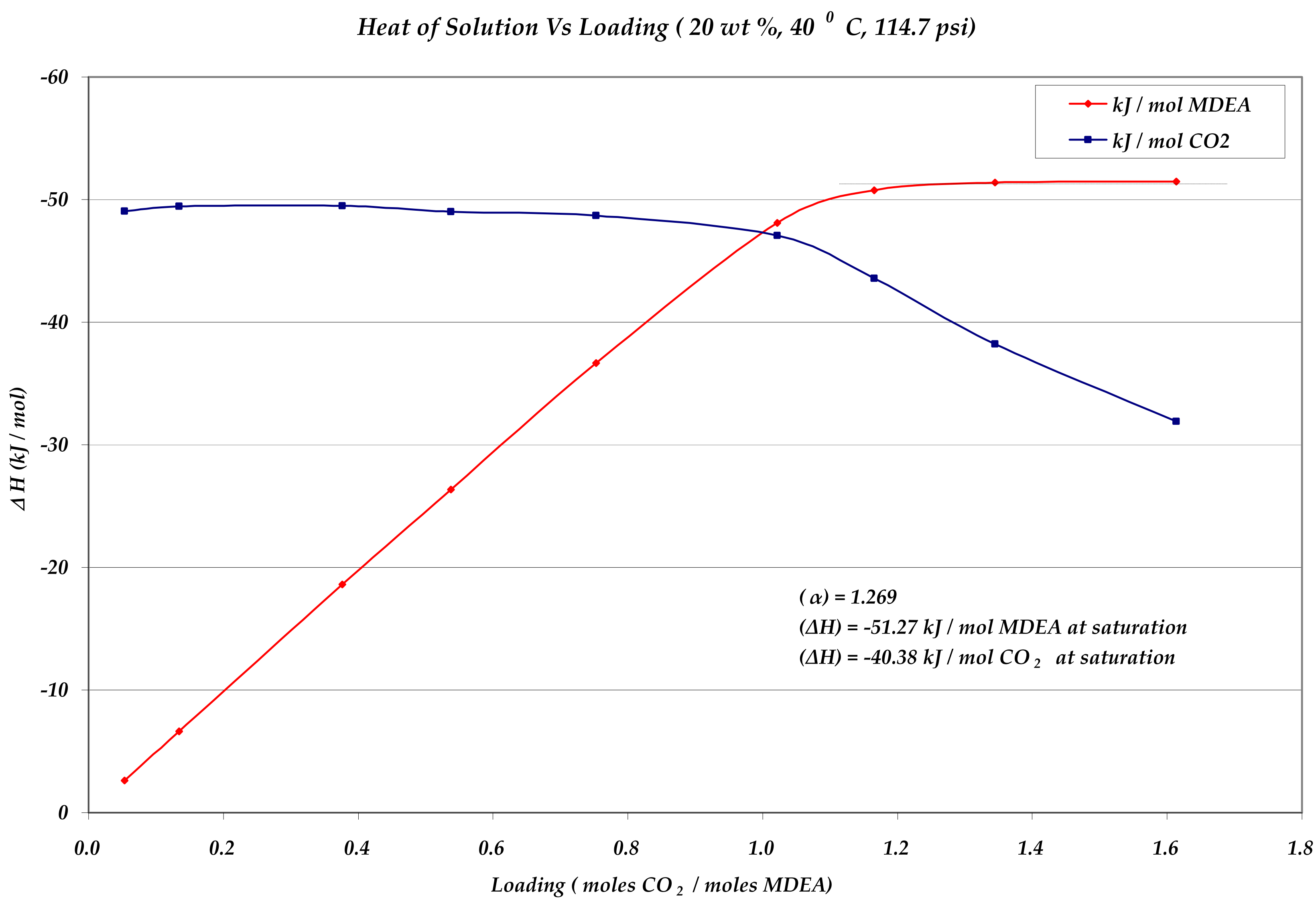

Figure 4: Enthalpy Vs Loading of CO_2 in 20 wt% MDEA solution at 40 ^{0} C and system pressure of 114.7 psi

Table 4: 20 wt % MDEA, 114.7 psi , 40 ^{0} C							
CO_2 Flow Rate SCCM	*CO_2 Mol/sec*	*MDEA Flow Rate ml/min*	*MDEA Mol/sec*	*Loading of CO_2*	*Average Enthalpy mJ/sec*	*Enthalpy ΔH (Average) kJ / mol CO_2*	*Enthalpy ΔH (Average) kJ / mol MDEA*
0.30	*2.2E-07*	*0.15*	*4.2E-06*	*0.054*	*-10.9*	*-49.04*	*-2.64*
0.50	*3.7E-07*	*0.10*	*2.8E-06*	*0.134*	*-18.4*	*-49.43*	*-6.65*
1.40	*1.0E-06*	*0.10*	*2.8E-06*	*0.377*	*-51.5*	*-49.48*	*-18.63*
1.00	*7.4E-07*	*0.05*	*1.4E-06*	*0.538*	*-36.5*	*-49.01*	*-26.36*
1.40	*1.0E-06*	*0.05*	*1.4E-06*	*0.753*	*-50.7*	*-48.70*	*-36.67*
1.90	*1.4E-06*	*0.05*	*1.4E-06*	*1.022*	*-66.5*	*-47.07*	*-48.10*
1.30	*9.7E-07*	*0.03*	*8.3E-07*	*1.165*	*-42.1*	*-43.55*	*-50.75*
1.50	*1.1E-06*	*0.03*	*8.3E-07*	*1.345*	*-42.6*	*-38.21*	*-51.38*
1.80	*1.3E-06*	*0.03*	*8.3E-07*	*1.614*	*-42.7*	*-31.90*	*-51.48*

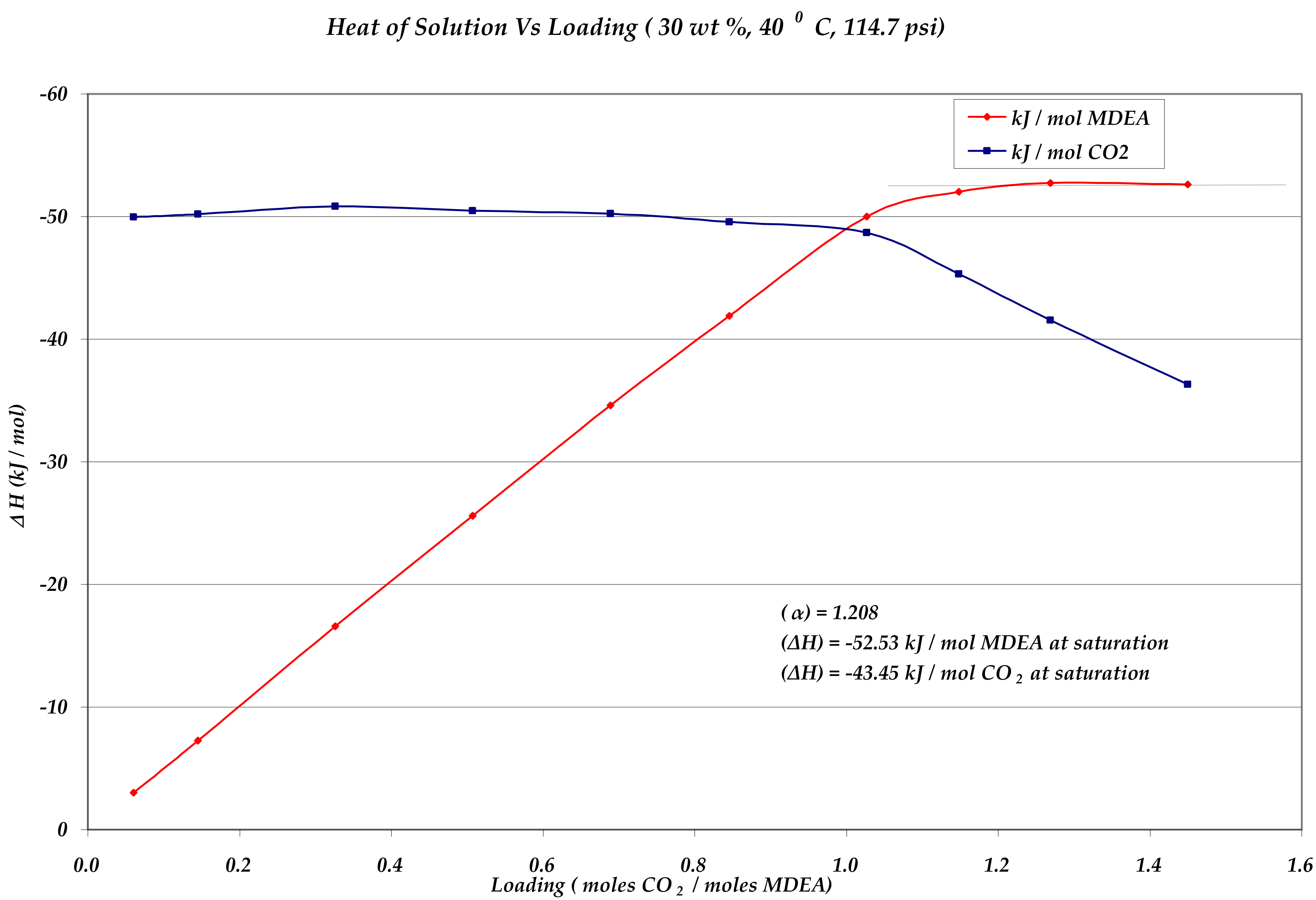

Figure 5: Enthalpy Vs Loading of CO_2 in 30 wt% MDEA solution at 40 ^{0} C and system pressure of 114.7 psi

Table 5: 30 wt % MDEA, 114.7 psi , 40 ^{0} C

CO_2 Flow Rate SCCM	*CO_2 Mol/sec*	*MDEA Flow Rate ml/min*	*MDEA Mol/sec*	*Loading of CO_2*	*Average Enthalpy mJ/sec*	*Enthalpy ΔH (Average) kJ / mol CO_2*	*Enthalpy ΔH (Average) kJ / mol MDEA*
0.50	3.7E-07	0.15	6.2E-06	0.060	-18.6	-49.95	-3.02
0.80	6.0E-07	0.10	4.1E-06	0.145	-29.9	-50.20	-7.28
1.80	1.3E-06	0.10	4.1E-06	0.326	-68.1	-50.83	-16.58
1.40	1.0E-06	0.05	2.1E-06	0.507	-52.6	-50.47	-25.61
1.90	1.4E-06	0.05	2.1E-06	0.689	-71.0	-50.24	-34.60
1.40	1.0E-06	0.03	1.2E-06	0.846	-51.6	-49.56	-41.91
1.70	1.3E-06	0.03	1.2E-06	1.027	-61.6	-48.68	-49.99
1.90	1.4E-06	0.03	1.2E-06	1.148	-64.1	-45.32	-52.02
1.40	1.0E-06	0.02	8.2E-07	1.269	-43.3	-41.56	-52.72
1.60	1.2E-06	0.02	8.2E-07	1.450	-43.2	-36.31	-52.64

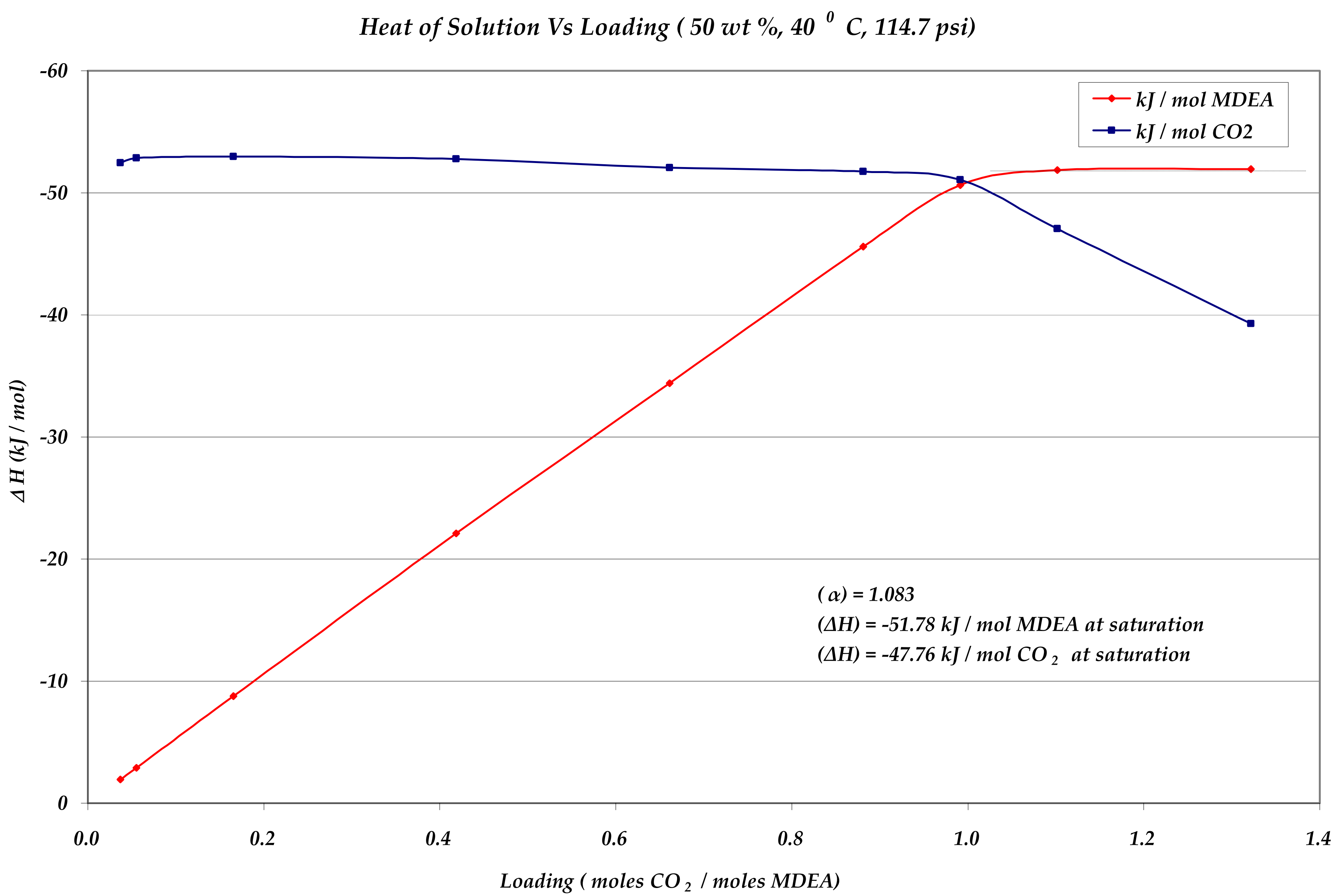

Figure 6: Enthalpy Vs Loading of CO_2 in 50 wt% MDEA solution at 40 ^{0} C and system pressure of 114.7 psi

Table 6: 50 wt % MDEA, 114.7 psi , 40 ^{0} C

CO_2 Flow Rate SCCM	CO_2 Mol/sec	MDEA Flow Rate ml/min	MDEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy ΔH (Average) kJ / mol MDEA
0.50	3.7E-07	0.15	1.0E-05	0.037	-19.5	-52.46	-1.93
0.50	3.7E-07	0.10	6.8E-06	0.055	-19.7	-52.85	-2.91
1.50	1.1E-06	0.10	6.8E-06	0.165	-59.1	-52.97	-8.75
1.90	1.4E-06	0.05	3.4E-06	0.419	-74.6	-52.77	-22.09
1.20	8.9E-07	0.02	1.4E-06	0.661	-46.5	-52.08	-34.42
1.60	1.2E-06	0.02	1.4E-06	0.881	-61.6	-51.74	-45.60
0.90	6.7E-07	0.01	6.8E-07	0.991	-34.2	-51.05	-50.62
1.00	7.4E-07	0.01	6.8E-07	1.102	-35.0	-47.07	-51.85
1.20	8.9E-07	0.01	6.8E-07	1.322	-35.1	-39.31	-51.96

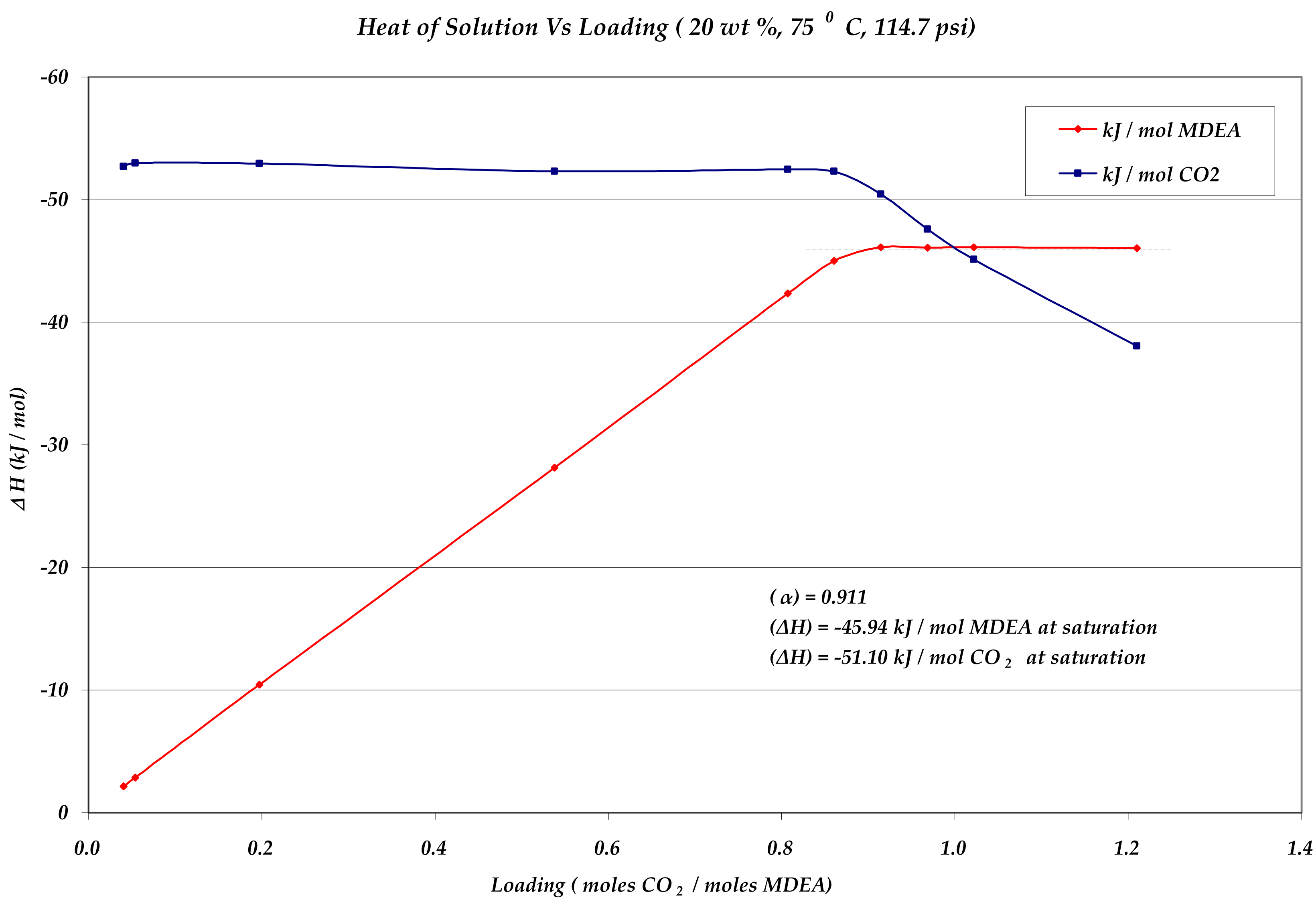

Figure 7: Enthalpy Vs Loading of CO_2 in 20 wt% MEA solution at 75 ^{0} C and system pressure of 114.7 psi

Table 7: 20 wt % MDEA, 114.7 psi , 75 ^{0} C

CO_2 Flow Rate SCCM	*CO_2 Mol/sec*	*MDEA Flow Rate ml/min*	*MDEA Mol/sec*	*Loading of CO_2*	*Average Enthalpy mJ/sec*	*Enthalpy ΔH (Average) kJ / mol CO_2*	*Enthalpy ΔH (Average) kJ / mol MDEA*
0.30	2.2E-07	0.20	5.5E-06	0.040	-11.8	-52.69	-2.13
0.30	2.2E-07	0.15	4.2E-06	0.054	-11.8	-52.98	-2.85
1.10	8.2E-07	0.15	4.2E-06	0.197	-43.3	-52.93	-10.44
1.00	7.4E-07	0.05	1.4E-06	0.538	-38.9	-52.31	-28.14
1.50	1.1E-06	0.05	1.4E-06	0.807	-58.6	-52.48	-42.34
1.60	1.2E-06	0.05	1.4E-06	0.861	-62.3	-52.31	-45.01
1.70	1.3E-06	0.05	1.4E-06	0.914	-63.8	-50.45	-46.13
1.80	1.3E-06	0.05	1.4E-06	0.968	-63.7	-47.58	-46.06
1.90	1.4E-06	0.05	1.4E-06	1.022	-63.8	-45.14	-46.13
0.90	6.7E-07	0.02	5.5E-07	1.210	-25.5	-38.04	-46.04

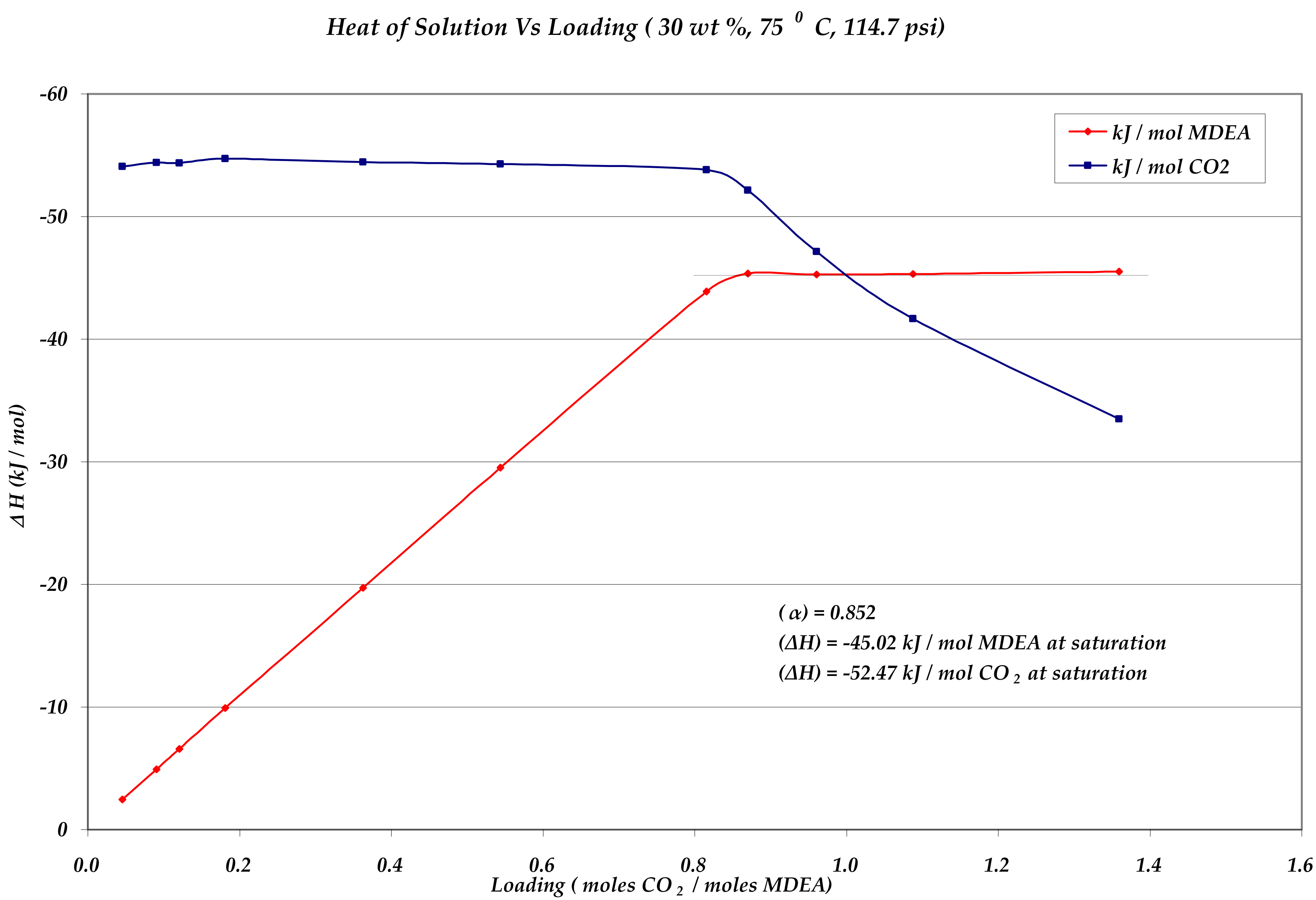

Figure 8: Enthalpy Vs Loading of CO_2 in 30 wt% MDEA solution at 75 ^{0} C and system pressure of 114.7 psi

Table 8: 30 wt % MDEA, 114.7 psi , 75 ⁰ C

CO_2 Flow Rate SCCM	CO_2 Mol/sec	MDEA Flow Rate ml/min	MDEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy ΔH (Average) kJ / mol MDEA
0.50	3.7E-07	0.20	8.2E-06	0.045	-20.1	-54.10	-2.45
1.00	7.4E-07	0.20	8.2E-06	0.091	-40.5	-54.42	-4.93
1.00	7.4E-07	0.15	6.2E-06	0.121	-40.5	-54.37	-6.57
1.00	7.4E-07	0.10	4.1E-06	0.181	-40.7	-54.71	-9.92
1.00	7.4E-07	0.05	2.1E-06	0.362	-40.5	-54.45	-19.73
1.50	1.1E-06	0.05	2.1E-06	0.544	-60.6	-54.28	-29.51
0.90	6.7E-07	0.02	8.2E-07	0.816	-36.0	-53.79	-43.87
0.96	7.1E-07	0.02	8.2E-07	0.870	-37.2	-52.13	-45.35
1.06	7.9E-07	0.02	8.2E-07	0.960	-37.2	-47.16	-45.30
3.00	2.2E-06	0.05	2.1E-06	1.087	-93.0	-41.68	-45.32
1.50	1.1E-06	0.02	8.2E-07	1.359	-37.4	-33.49	-45.52

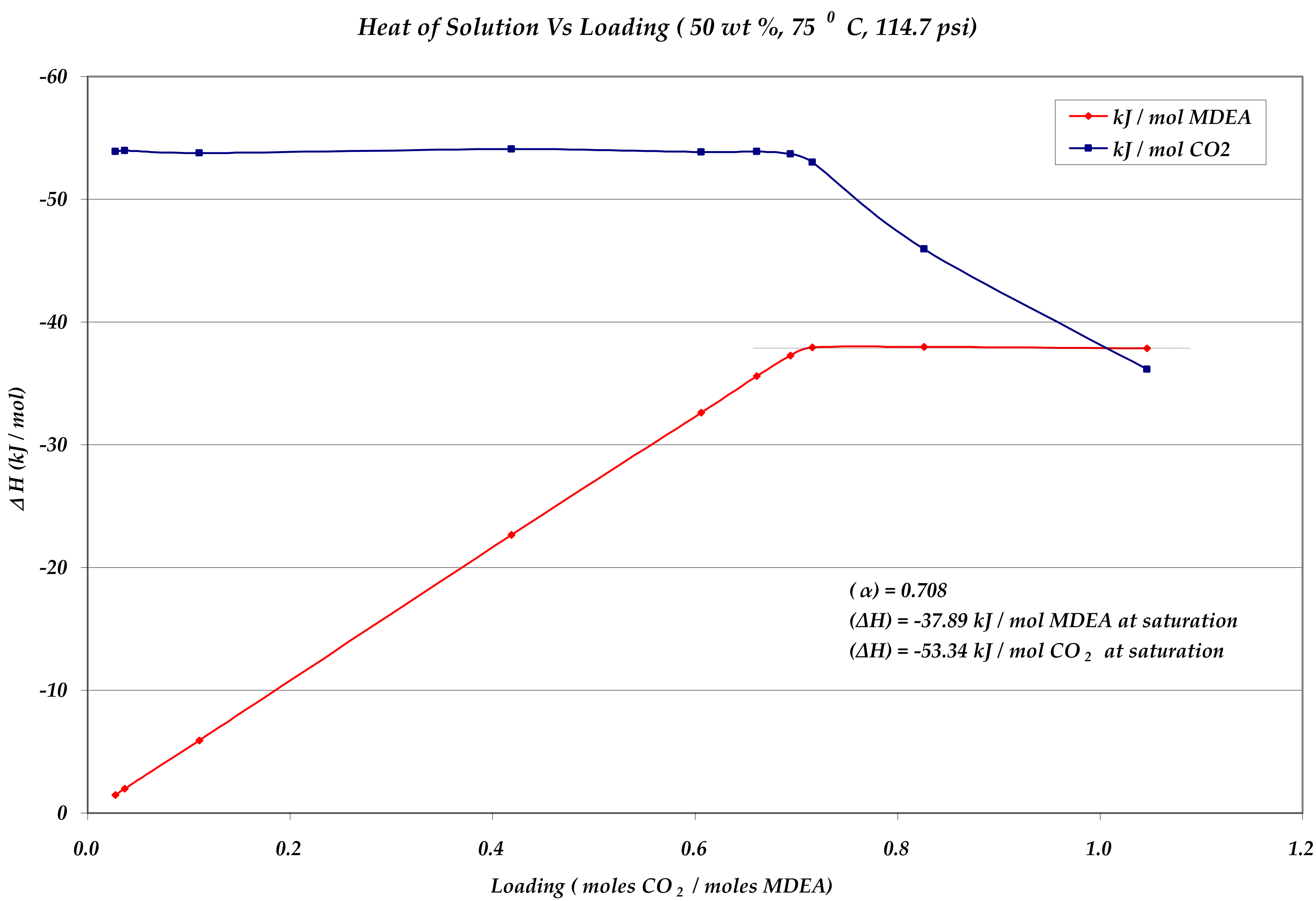

Figure 9: Enthalpy Vs Loading of CO_2 in 50 wt% MDEA solution at 75 ^{0} C and system pressure of 114.7 psi

Table 9: 50 wt % MDEA, 114.7 psi , 75 ⁰ C

CO_2 Flow Rate SCCM	*CO_2 Mol/sec*	*MDEA Flow Rate ml/min*	*MDEA Mol/sec*	*Loading of CO_2*	*Average Enthalpy mJ/sec*	*Enthalpy ΔH (Average) kJ / mol CO_2*	*Enthalpy ΔH (Average) kJ / mol MDEA*
0.50	*3.7E-07*	*0.20*	*1.4E-05*	*0.028*	*-20.0*	*-53.88*	*-1.48*
0.50	*3.7E-07*	*0.15*	*1.0E-05*	*0.037*	*-20.1*	*-53.96*	*-1.98*
1.00	*7.4E-07*	*0.10*	*6.8E-06*	*0.110*	*-40.0*	*-53.79*	*-5.93*
1.90	*1.4E-06*	*0.05*	*3.4E-06*	*0.419*	*-76.5*	*-54.10*	*-22.65*
1.10	*8.2E-07*	*0.02*	*1.4E-06*	*0.606*	*-44.1*	*-53.84*	*-32.62*
1.20	*8.9E-07*	*0.02*	*1.4E-06*	*0.661*	*-48.1*	*-53.88*	*-35.61*
1.26	*9.4E-07*	*0.02*	*1.4E-06*	*0.694*	*-50.3*	*-53.68*	*-37.26*
1.30	*9.7E-07*	*0.02*	*1.4E-06*	*0.716*	*-51.3*	*-53.00*	*-37.95*
1.50	*1.1E-06*	*0.02*	*1.4E-06*	*0.826*	*-51.3*	*-45.97*	*-37.98*
1.90	*1.4E-06*	*0.02*	*1.4E-06*	*1.047*	*-51.1*	*-36.17*	*-37.85*

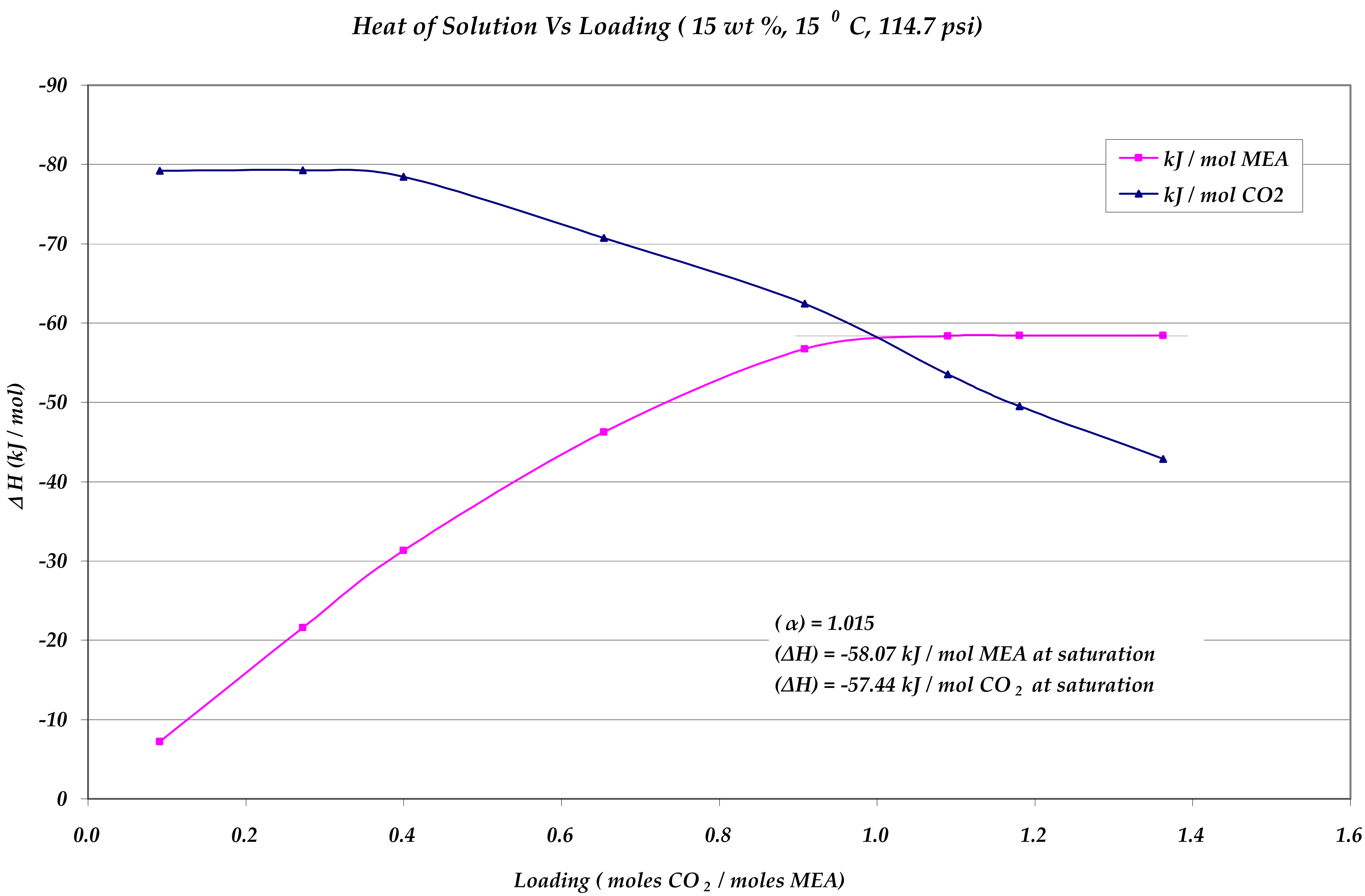

Figure 10: Enthalpy Vs Loading of CO_2 in 15 wt% MEA solution at 15 ^{0} C and system pressure of 114.7 psi

Table 10: 15 wt % MEA, 114.7 psi , 15 ^{0} C

CO_2 Flow Rate SCCM	CO_2 Mol/sec	MEA Flow Rate ml/min	MEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy ΔH (Average) kJ / mol MEA
0.50	3.7E-07	0.10	4.1E-06	0.091	-29.5	-79.18	-7.19
1.50	1.1E-06	0.10	4.1E-06	0.272	-88.5	-79.28	-21.60
1.10	8.2E-07	0.05	2.0E-06	0.400	-64.2	-78.43	-31.34
1.80	1.3E-06	0.05	2.0E-06	0.654	-94.7	-70.74	-46.26
1.00	7.4E-07	0.02	8.2E-07	0.908	-46.5	-62.45	-56.71
1.20	8.9E-07	0.02	8.2E-07	1.090	-47.8	-53.56	-58.37
1.30	9.7E-07	0.02	8.2E-07	1.181	-47.9	-49.50	-58.44
1.50	1.1E-06	0.02	8.2E-07	1.362	-47.9	-42.90	-58.44

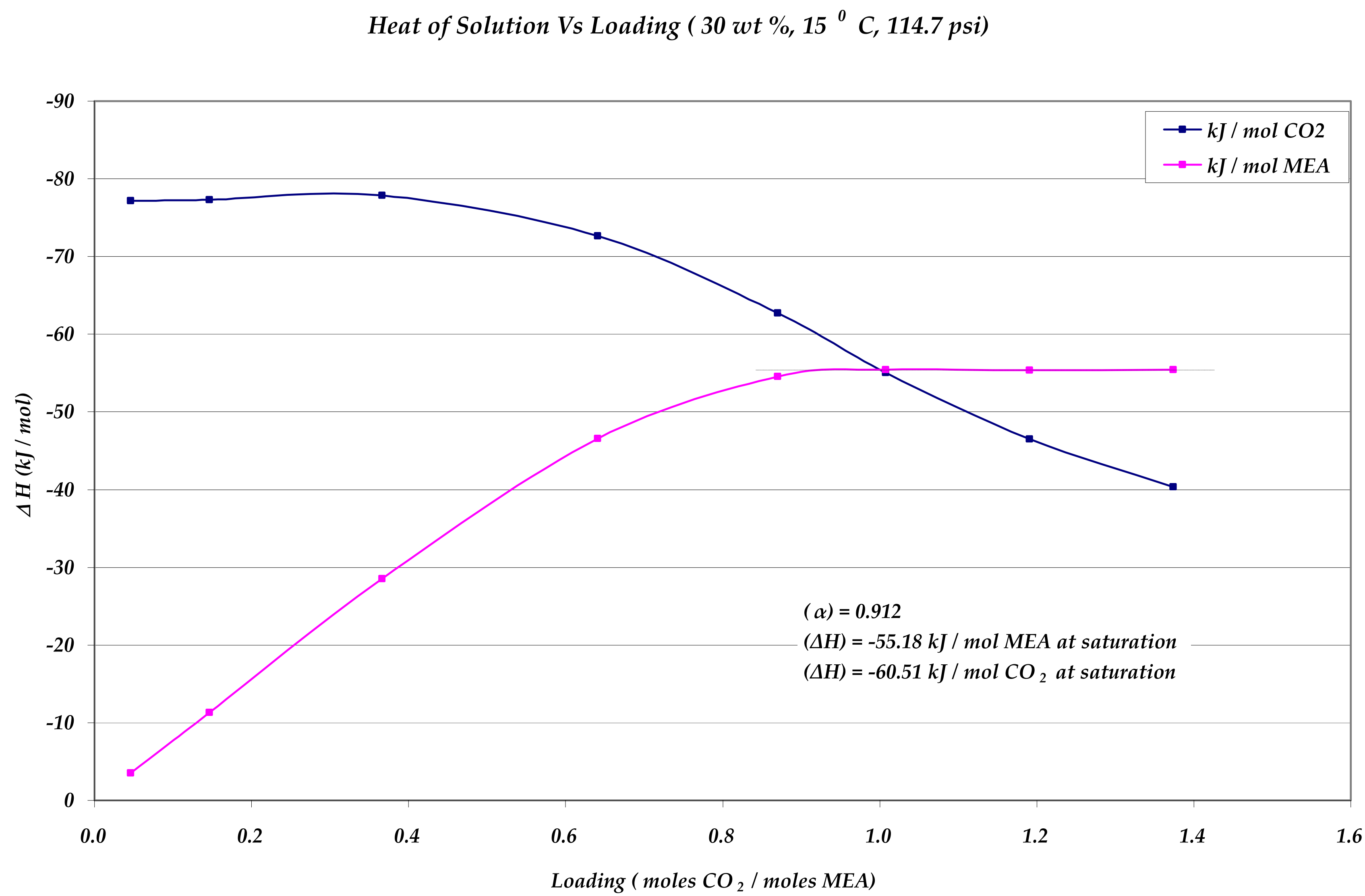

Figure 11: Enthalpy Vs Loading of CO_2 in 30 wt% MEA solution at 15 ^{0} C and system pressure of 114.7 psi

Table 11: 30 wt % MEA, 114.7 psi , 15 ⁰ C

CO_2 Flow Rate SCCM	*CO_2 Mol/sec*	*MEA Flow Rate ml/min*	*MEA Mol/sec*	*Loading of CO_2*	*Average Enthalpy mJ/sec*	*Enthalpy ΔH (Average) kJ / mol CO_2*	*Enthalpy ΔH (Average) kJ / mol MEA*
0.50	3.7E-07	0.10	8.1E-06	0.046	-28.7	-77.20	-3.54
0.80	6.0E-07	0.05	4.1E-06	0.147	-46.0	-77.33	-11.33
0.80	6.0E-07	0.02	1.6E-06	0.366	-46.4	-77.87	-28.53
1.40	1.0E-06	0.02	1.6E-06	0.641	-75.7	-72.67	-46.59
1.90	1.4E-06	0.02	1.6E-06	0.870	-88.6	-62.69	-54.55
1.10	8.2E-07	0.01	8.1E-07	1.007	-45.0	-55.04	-55.45
1.30	9.7E-07	0.01	8.1E-07	1.191	-45.0	-46.52	-55.39
1.50	1.1E-06	0.01	8.1E-07	1.374	-45.0	-40.34	-55.42

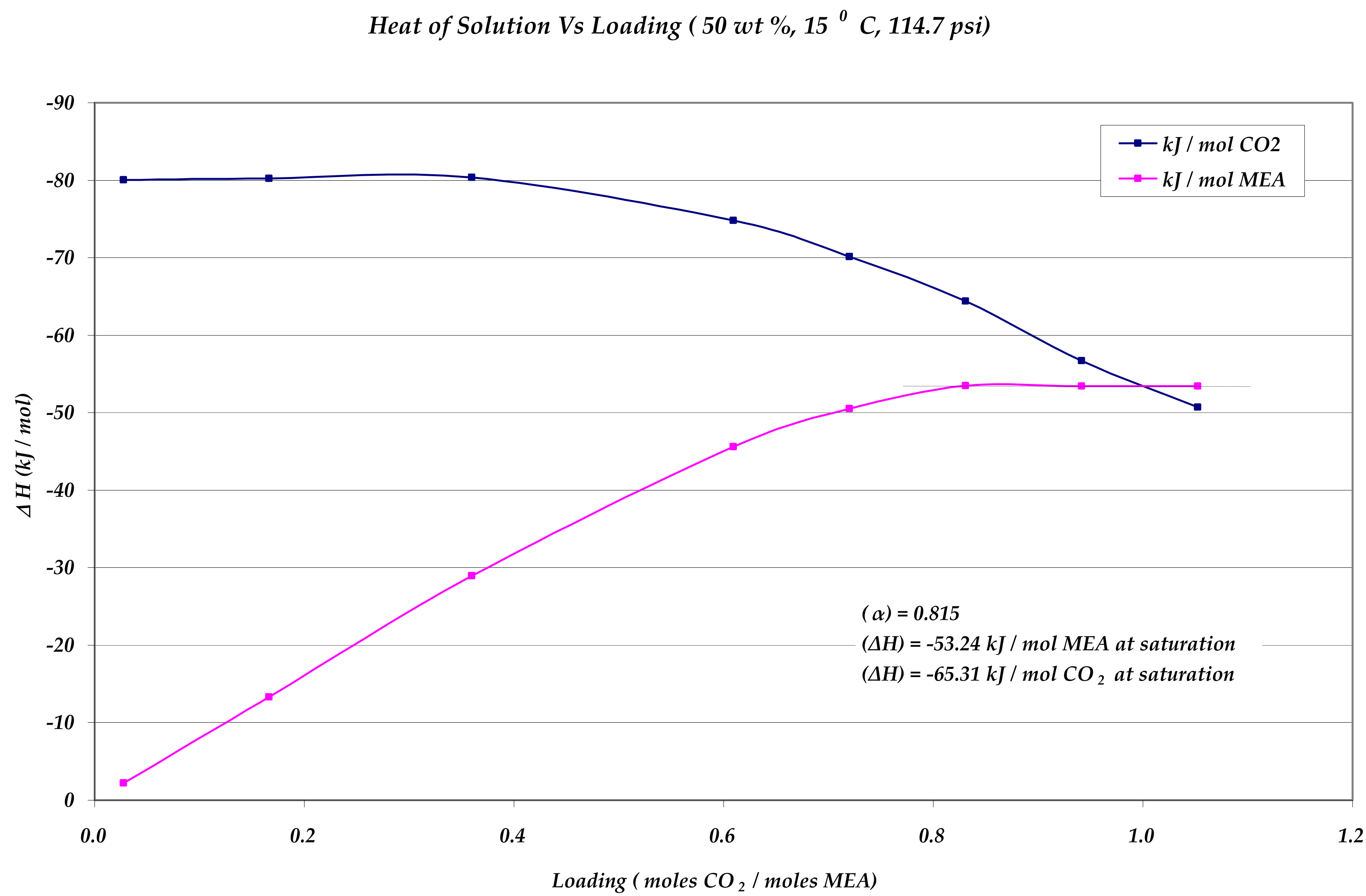

Figure 12: Enthalpy Vs Loading of CO_2 in 50 wt% MEA solution at 15 ^{0} C and system pressure of 114.7 psi

Table 12: 50 wt % MEA, 114.7 psi , 15 ^{0} C

CO_2 Flow Rate SCCM	*CO_2 Mol/sec*	*MEA Flow Rate ml/min*	*MEA Mol/sec*	*Loading of CO_2*	*Average Enthalpy mJ/sec*	*Enthalpy ΔH (Average) kJ / mol CO_2*	*Enthalpy ΔH (Average) kJ / mol MEA*
0.50	3.7E-07	0.10	1.3E-05	0.028	-29.8	-80.02	-2.22
1.50	1.1E-06	0.05	6.7E-06	0.166	-89.5	-80.24	-13.33
1.30	9.7E-07	0.02	2.7E-06	0.360	-77.7	-80.36	-28.93
1.10	8.2E-07	0.01	1.3E-06	0.609	-61.2	-74.83	-45.60
1.30	9.7E-07	0.01	1.3E-06	0.720	-67.9	-70.16	-50.52
1.50	1.1E-06	0.01	1.3E-06	0.831	-71.8	-64.37	-53.49
1.70	1.3E-06	0.01	1.3E-06	0.942	-71.7	-56.71	-53.40
1.90	1.4E-06	0.01	1.3E-06	1.052	-71.7	-50.74	-53.40

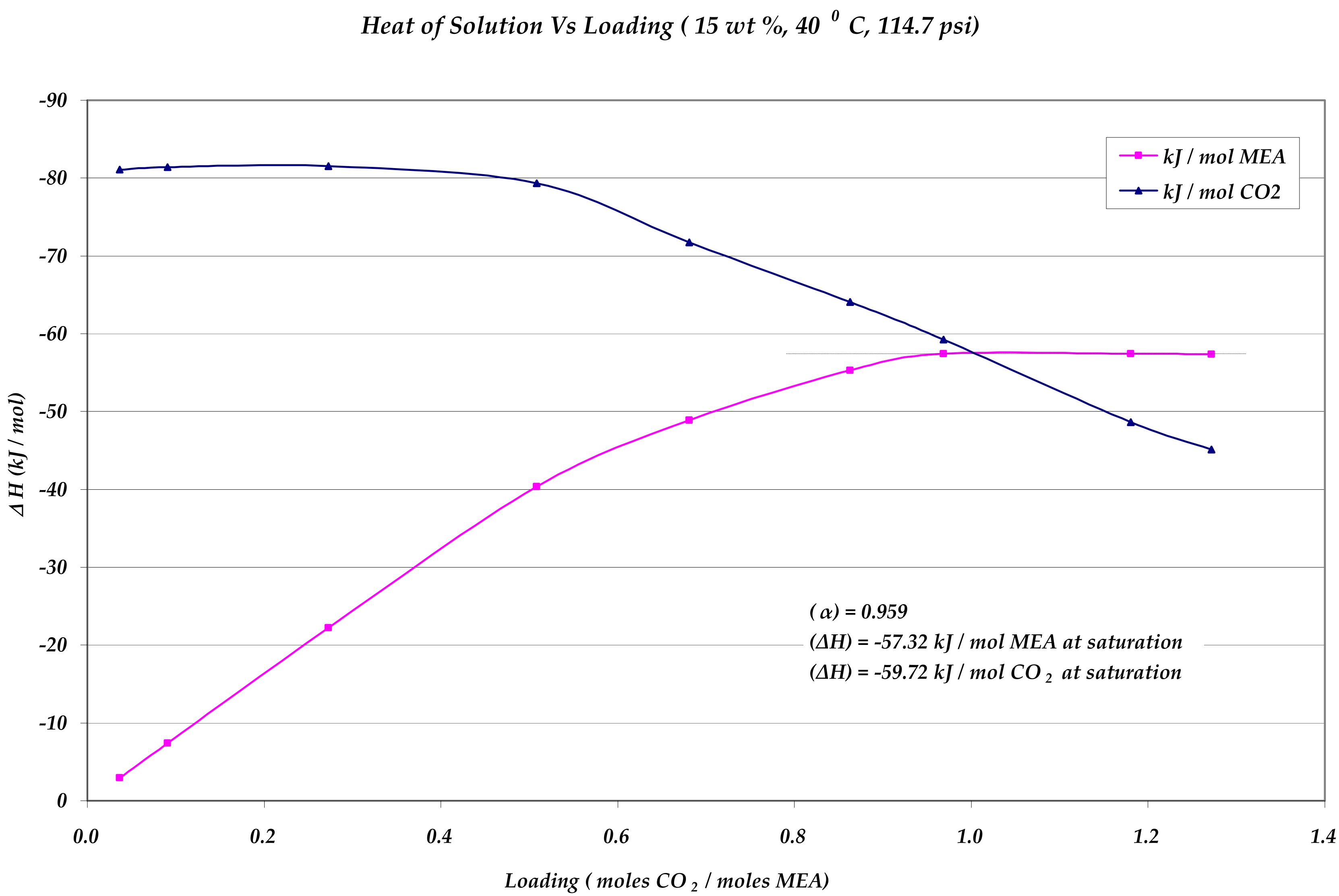

Figure 13: Enthalpy Vs Loading of CO_2 in 15 wt% MEA solution at 40 ^{0} C and system pressure of 114.7 psi

Table 13: 15 wt % MEA, 114.7 psi , 40 ^{0} C

CO_2 Flow Rate SCCM	*CO_2 Mol/sec*	*MEA Flow Rate ml/min*	*MEA Mol/sec*	*Loading of CO_2*	*Average Enthalpy mJ/sec*	*Enthalpy ΔH (Average) kJ / mol CO_2*	*Enthalpy DH (Average) kJ / mol MEA*
0.30	2.2E-07	0.15	6.1E-06	0.036	-18.1	-81.06	-2.94
0.50	3.7E-07	0.10	4.1E-06	0.091	-30.3	-81.41	-7.39
1.50	1.1E-06	0.10	4.1E-06	0.272	-91.0	-81.50	-22.21
1.40	1.0E-06	0.05	2.0E-06	0.509	-82.6	-79.30	-40.33
1.50	1.1E-06	0.04	1.6E-06	0.681	-80.1	-71.74	-48.87
1.90	1.4E-06	0.04	1.6E-06	0.863	-90.6	-64.08	-55.28
1.60	1.2E-06	0.03	1.2E-06	0.969	-70.5	-59.25	-57.40
1.30	9.7E-07	0.02	8.2E-07	1.181	-47.1	-48.66	-57.45
1.40	1.0E-06	0.02	8.2E-07	1.271	-47.0	-45.10	-57.34

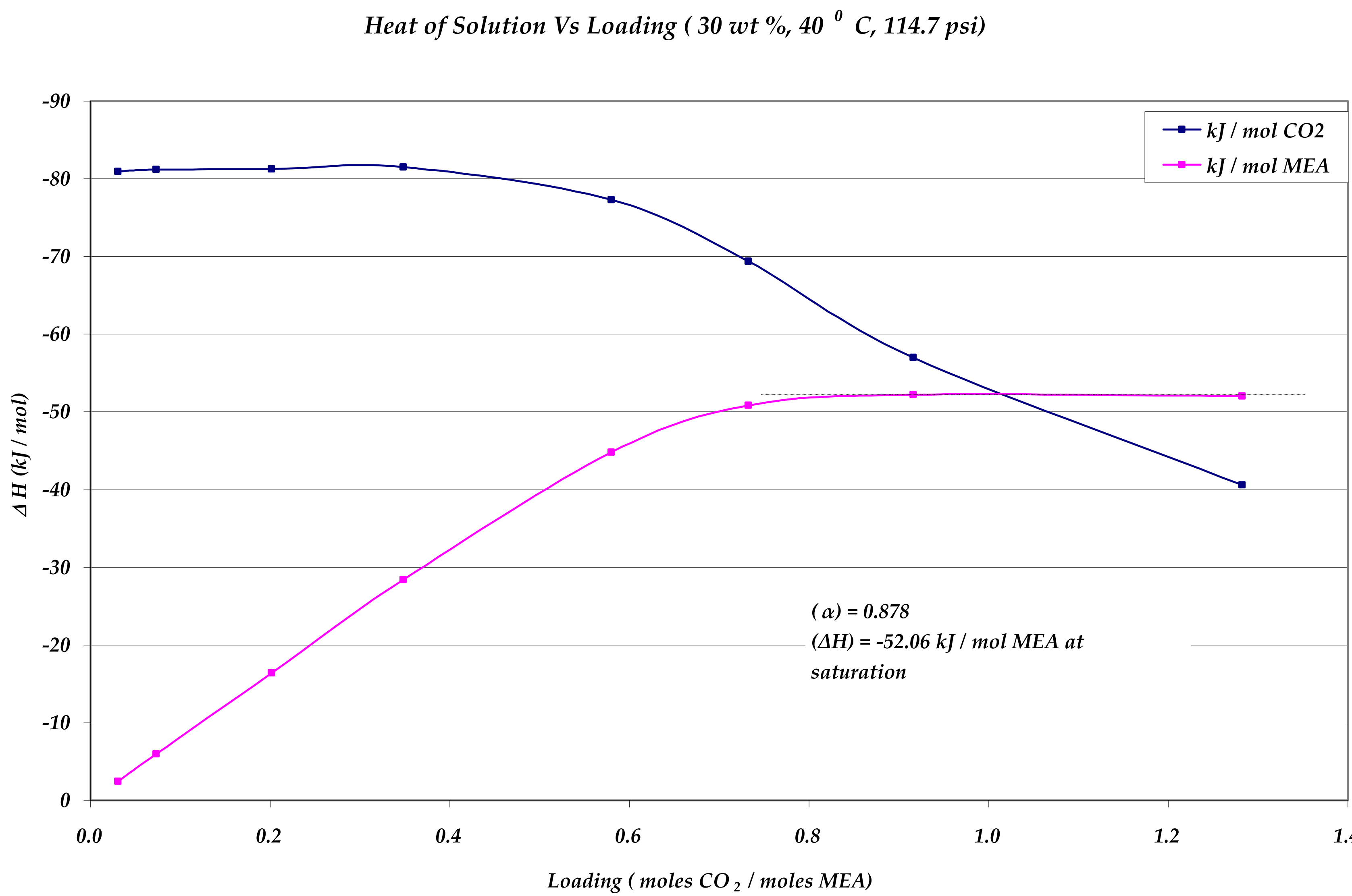

Figure 14: Enthalpy Vs Loading of CO_2 in 30 wt% MEA solution at 40 ^{0} C and system pressure of 114.7 psi

Table 14: 30 wt % MEA, 114.7 psi , 40 ^{0} C

CO_2 Flow Rate SCCM	*CO_2 Mol/sec*	*MEA Flow Rate ml/min*	*MEA Mol/sec*	*Loading of CO_2*	*Average Enthalpy mJ/sec*	*Enthalpy ΔH (Average) kJ / mol CO_2*	*Enthalpy DH (Average) kJ / mol MEA*
0.50	*3.7E-07*	*0.15*	*1.2E-05*	*0.031*	*-30.1*	*-80.93*	*-2.47*
0.80	*6.0E-07*	*0.10*	*8.1E-06*	*0.073*	*-48.3*	*-81.17*	*-5.95*
1.10	*8.2E-07*	*0.05*	*4.1E-06*	*0.201*	*-66.5*	*-81.28*	*-16.38*
1.90	*1.4E-06*	*0.05*	*4.1E-06*	*0.348*	*-115.3*	*-81.55*	*-28.38*
1.90	*1.4E-06*	*0.03*	*2.4E-06*	*0.580*	*-109.2*	*-77.28*	*-44.82*
1.60	*1.2E-06*	*0.02*	*1.6E-06*	*0.733*	*-82.6*	*-69.39*	*-50.84*
1.00	*7.4E-07*	*0.01*	*8.1E-07*	*0.916*	*-42.4*	*-57.02*	*-52.22*
1.40	*1.0E-06*	*0.01*	*8.1E-07*	*1.282*	*-42.3*	*-40.59*	*-52.04*

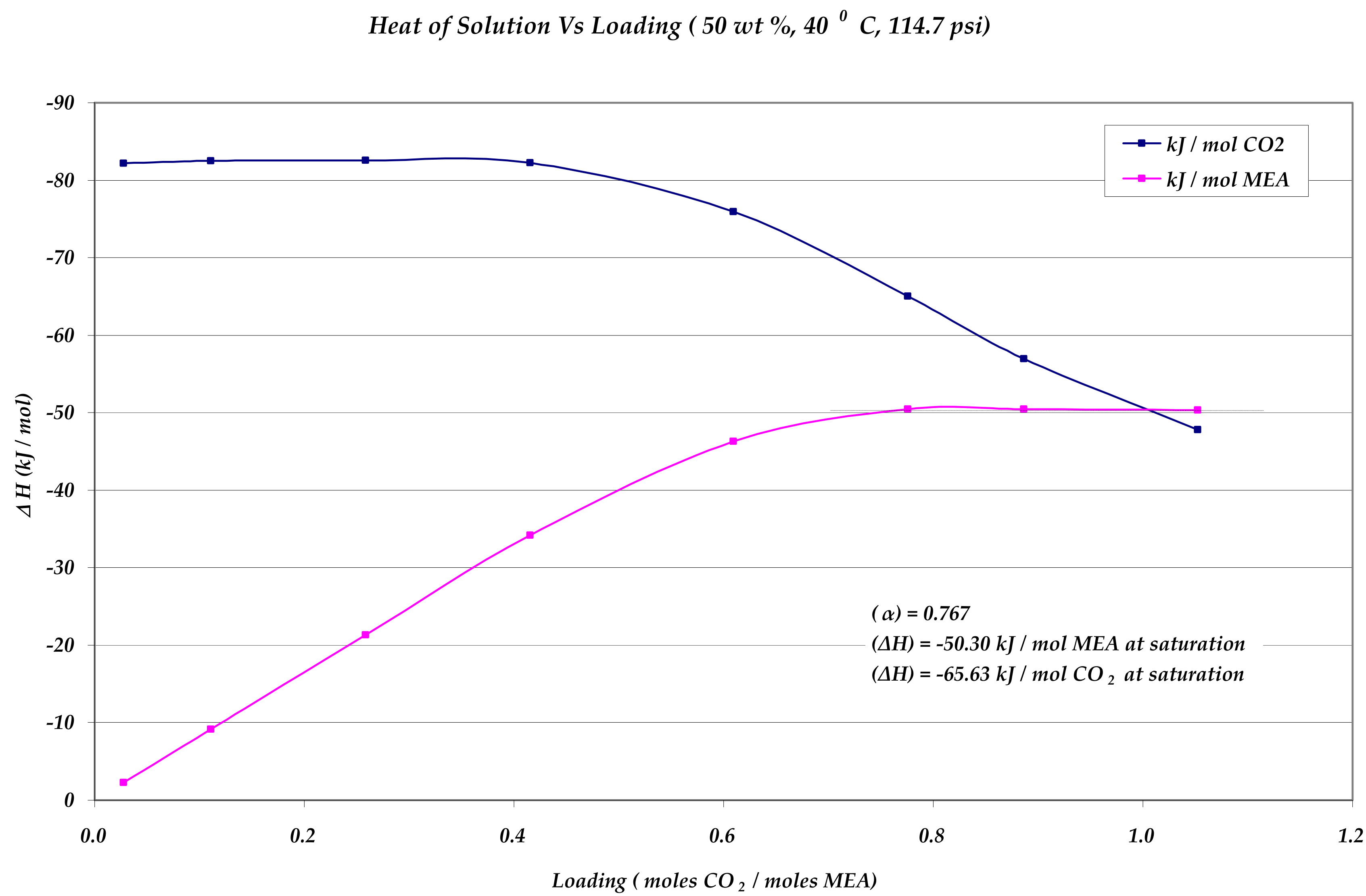

Figure 15: Enthalpy Vs Loading of CO_2 in 50 wt% MEA solution at 40 ^{0} C and system pressure of 114.7 psi

Table 15: 50 wt % MEA, 114.7 psi , 40 ⁰ C

CO_2 Flow Rate SCCM	CO_2 Mol/sec	MEA Flow Rate ml/min	MEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy DH (Average) kJ / mol MEA
0.50	3.7E-07	0.10	1.3E-05	0.028	-30.6	-82.20	-2.28
1.00	7.4E-07	0.05	6.7E-06	0.111	-61.4	-82.47	-9.14
1.40	1.0E-06	0.03	4.0E-06	0.258	-86.0	-82.53	-21.33
1.50	1.1E-06	0.02	2.7E-06	0.415	-91.8	-82.26	-34.17
1.10	8.2E-07	0.01	1.3E-06	0.609	-62.2	-75.95	-46.28
1.40	1.0E-06	0.01	1.3E-06	0.775	-67.7	-65.03	-50.43
1.60	1.2E-06	0.01	1.3E-06	0.886	-67.8	-56.94	-50.46
1.90	1.4E-06	0.01	1.3E-06	1.052	-67.6	-47.80	-50.31

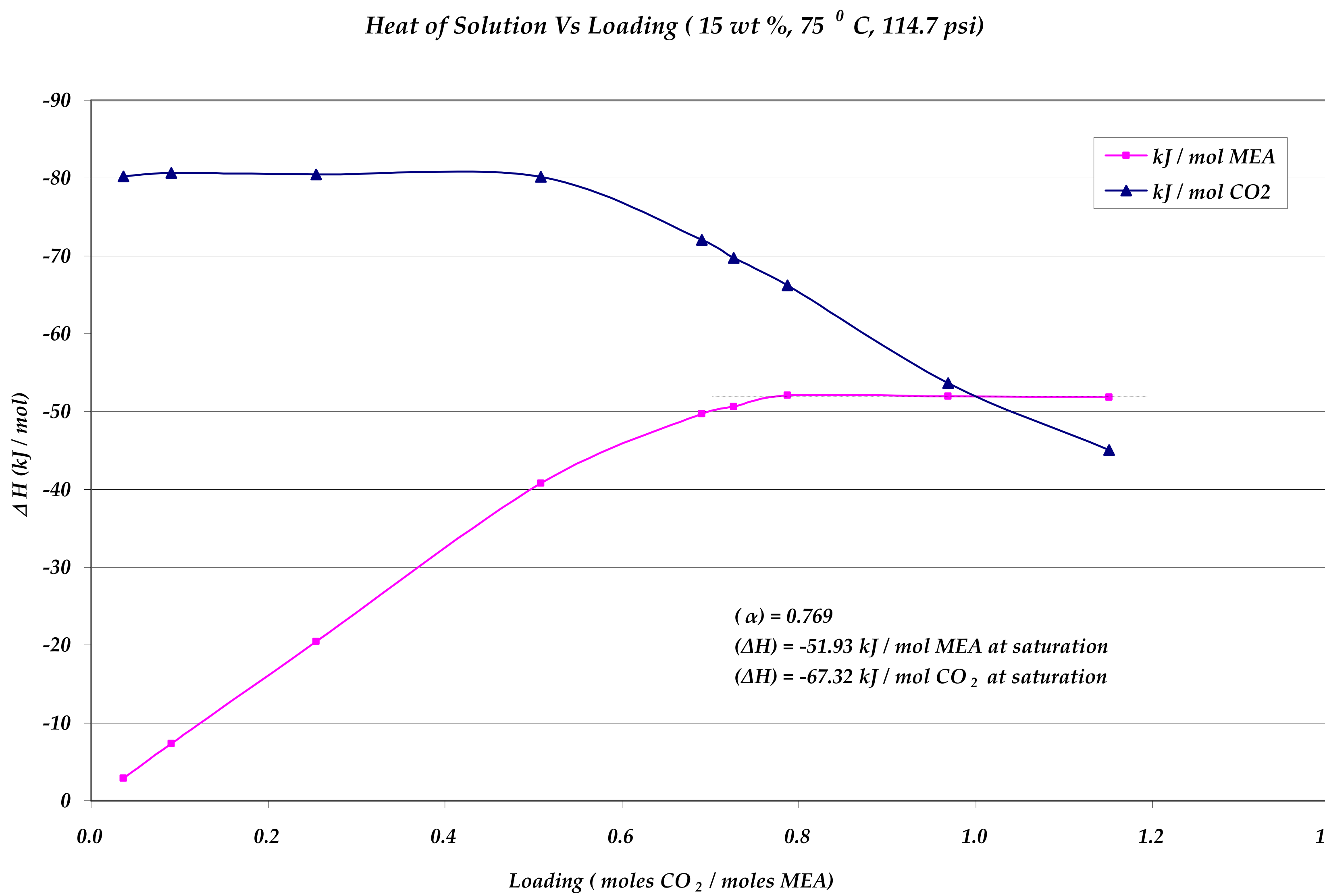

Figure 16: Enthalpy Vs Loading of CO_2 in 15 wt% MEA solution at 75 ^{0} C and system pressure of 114.7 psi

Table 16: 15 wt % MEA, 114.7 psi , 75 ^{0} C

CO_2 Flow Rate SCCM	*CO_2 Mol/sec*	*MEA Flow Rate ml/min*	*MEA Mol/sec*	*Loading of CO_2*	*Average Enthalpy mJ/sec*	*Enthalpy ΔH (Average) kJ / mol CO_2*	*Enthalpy DH (Average) kJ / mol MEA*
0.30	2.2E-07	0.15	6.1E-06	0.036	-17.9	-80.24	-2.91
0.50	3.7E-07	0.10	4.1E-06	0.091	-30.0	-80.63	-7.32
0.70	5.2E-07	0.05	2.0E-06	0.254	-41.9	-80.49	-20.47
1.40	1.0E-06	0.05	2.0E-06	0.509	-83.5	-80.16	-40.77
1.90	1.4E-06	0.05	2.0E-06	0.690	-101.9	-72.05	-49.73
1.20	8.9E-07	0.03	1.2E-06	0.727	-62.2	-69.71	-50.65
1.30	9.7E-07	0.03	1.2E-06	0.787	-64.0	-66.18	-52.09
1.60	1.2E-06	0.03	1.2E-06	0.969	-63.9	-53.64	-51.96
1.90	1.4E-06	0.03	1.2E-06	1.150	-63.7	-45.06	-51.83

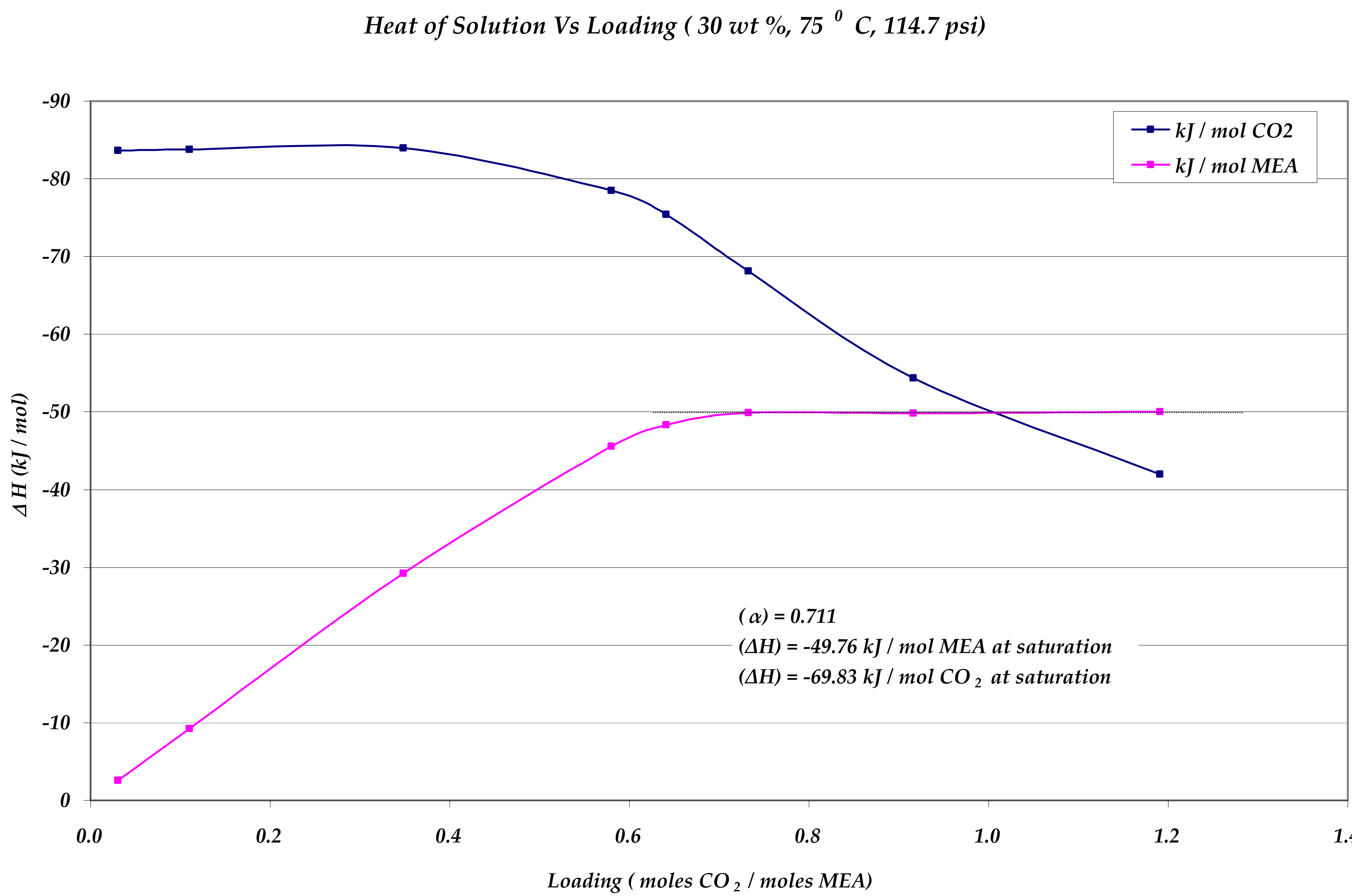

Figure 17: Enthalpy Vs Loading of CO_2 in 30 wt% MEA solution at 75 ^{0} C and system pressure of 114.7 psi

Table 17: 30 wt % MEA, 114.7 psi , 75 ^{0} C

CO_2 Flow Rate SCCM	CO_2 Mol/sec	MEA Flow Rate ml/min	MEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy DH (Average) kJ / mol MEA
0.50	3.7E-07	0.15	1.2E-05	0.031	-31.1	-83.68	-2.55
1.20	8.9E-07	0.10	8.1E-06	0.110	-74.8	-83.80	-9.21
1.90	1.4E-06	0.05	4.1E-06	0.348	-118.7	-83.98	-29.23
1.90	1.4E-06	0.03	2.4E-06	0.580	-111.0	-78.51	-45.54
1.40	1.0E-06	0.02	1.6E-06	0.641	-78.6	-75.44	-48.36
1.60	1.2E-06	0.02	1.6E-06	0.733	-81.1	-68.13	-49.91
1.00	7.4E-07	0.01	8.1E-07	0.916	-40.5	-54.39	-49.82
1.30	9.7E-07	0.01	8.1E-07	1.191	-40.6	-42.01	-50.02

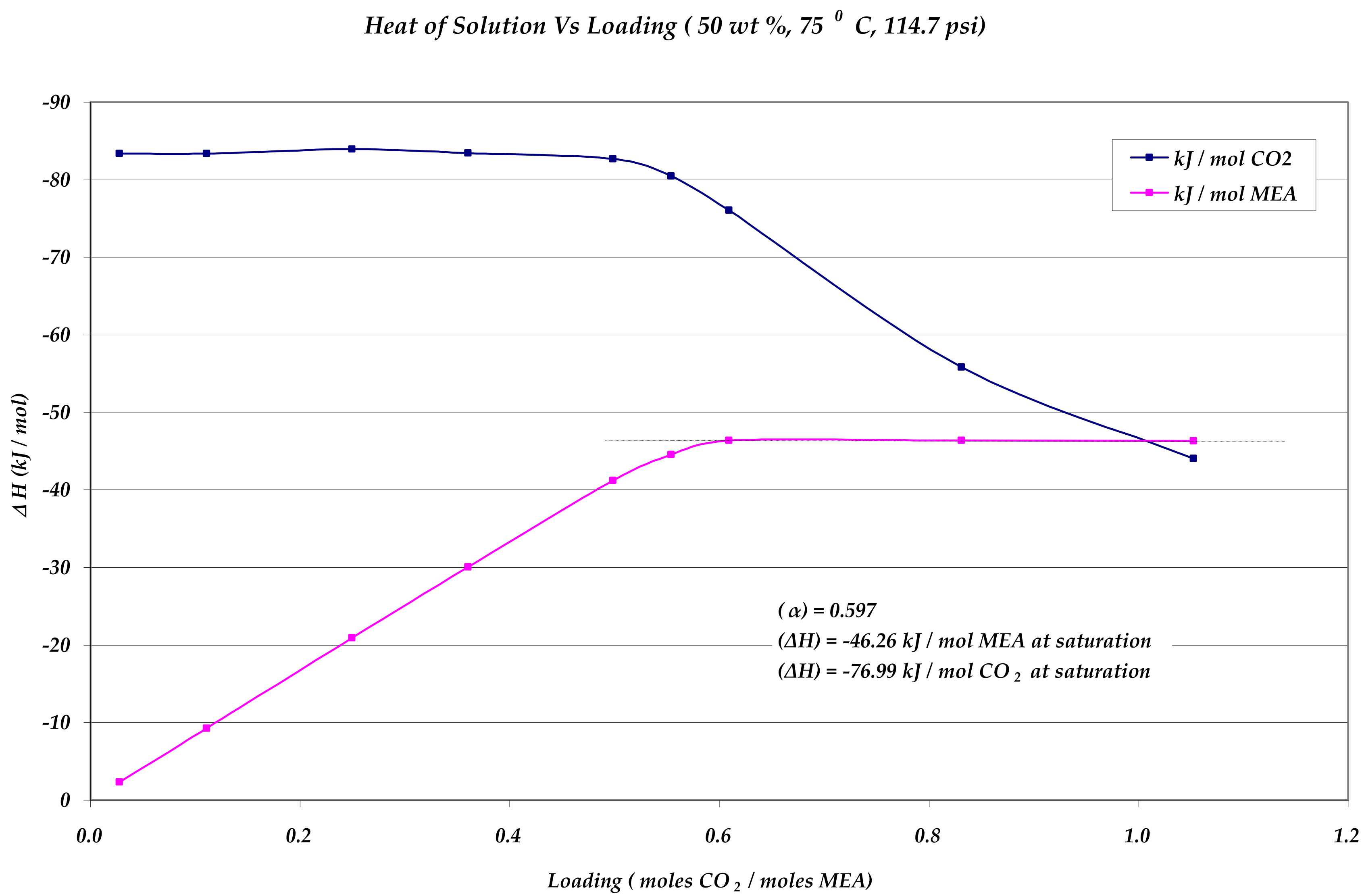

Figure 18: Enthalpy Vs Loading of CO_2 in 50 wt% MEA solution at 75 ^{0} C and system pressure of 114.7 psi

Table 18: 50 wt % MEA, 114.7 psi , 75 ^{0} C

CO_2 Flow Rate SCCM	*CO_2 Mol/sec*	*MEA Flow Rate ml/min*	*MEA Mol/sec*	*Loading of CO_2*	*Average Enthalpy mJ/sec*	*Enthalpy ΔH (Average) kJ / mol CO_2*	*Enthalpy DH (Average) kJ / mol MEA*
0.50	3.7E-07	0.10	1.3E-05	0.028	-31.0	-83.39	-2.31
1.00	7.4E-07	0.05	6.7E-06	0.111	-62.0	-83.38	-9.24
1.80	1.3E-06	0.04	5.4E-06	0.249	-112.4	-83.93	-20.92
1.30	9.7E-07	0.02	2.7E-06	0.360	-80.7	-83.43	-30.04
1.80	1.3E-06	0.02	2.7E-06	0.499	-110.8	-82.70	-41.23
1.00	7.4E-07	0.01	1.3E-06	0.554	-59.9	-80.47	-44.57
1.10	8.2E-07	0.01	1.3E-06	0.609	-62.3	-76.09	-46.37
1.50	1.1E-06	0.01	1.3E-06	0.831	-62.3	-55.85	-46.41
1.90	1.4E-06	0.01	1.3E-06	1.052	-62.3	-44.04	-46.35

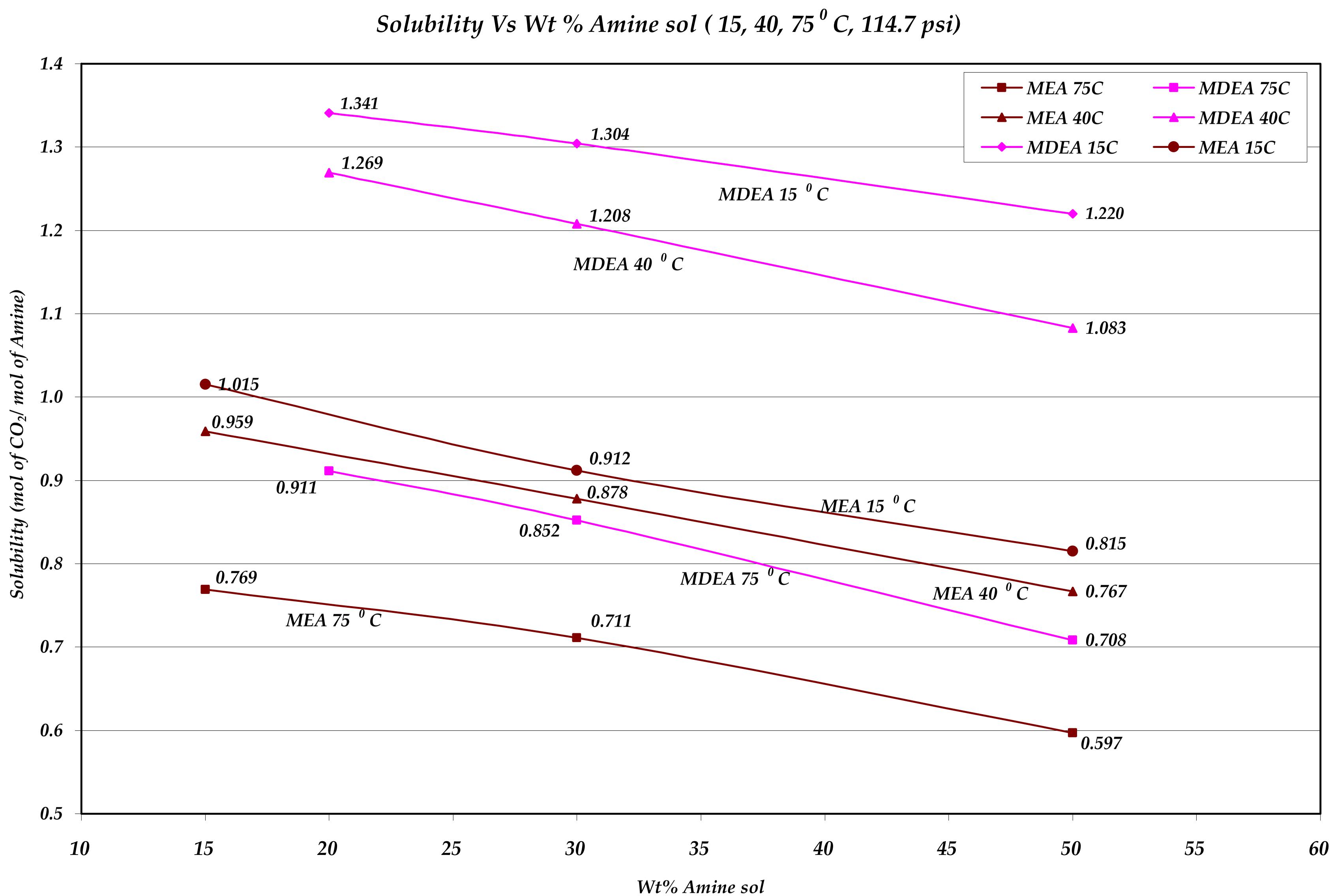

Figure 19: Solubility versus solvent concentrations at fixed temperatures.

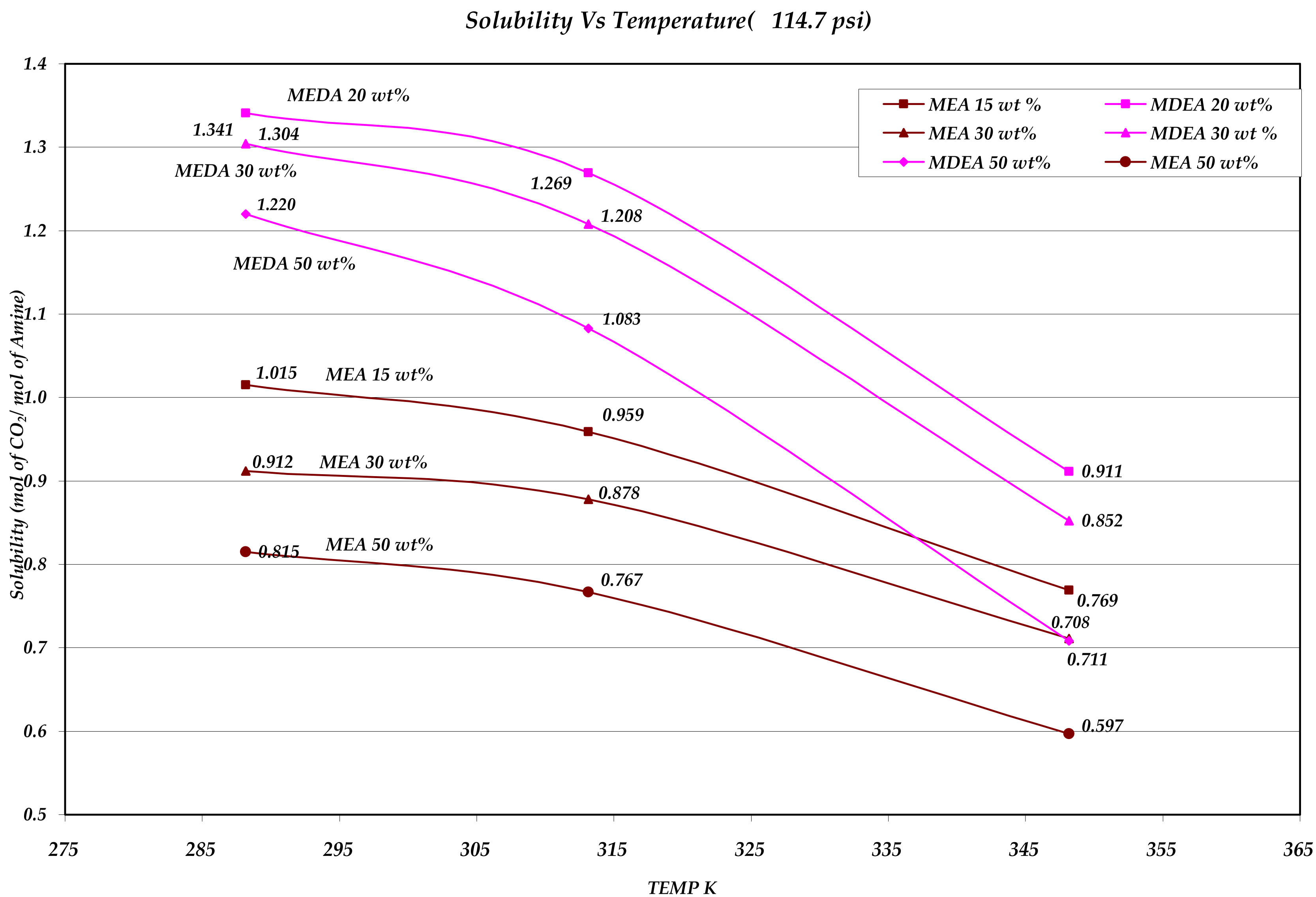

Figure 20: Solubility versus temperature at fixed solvent concentrations.

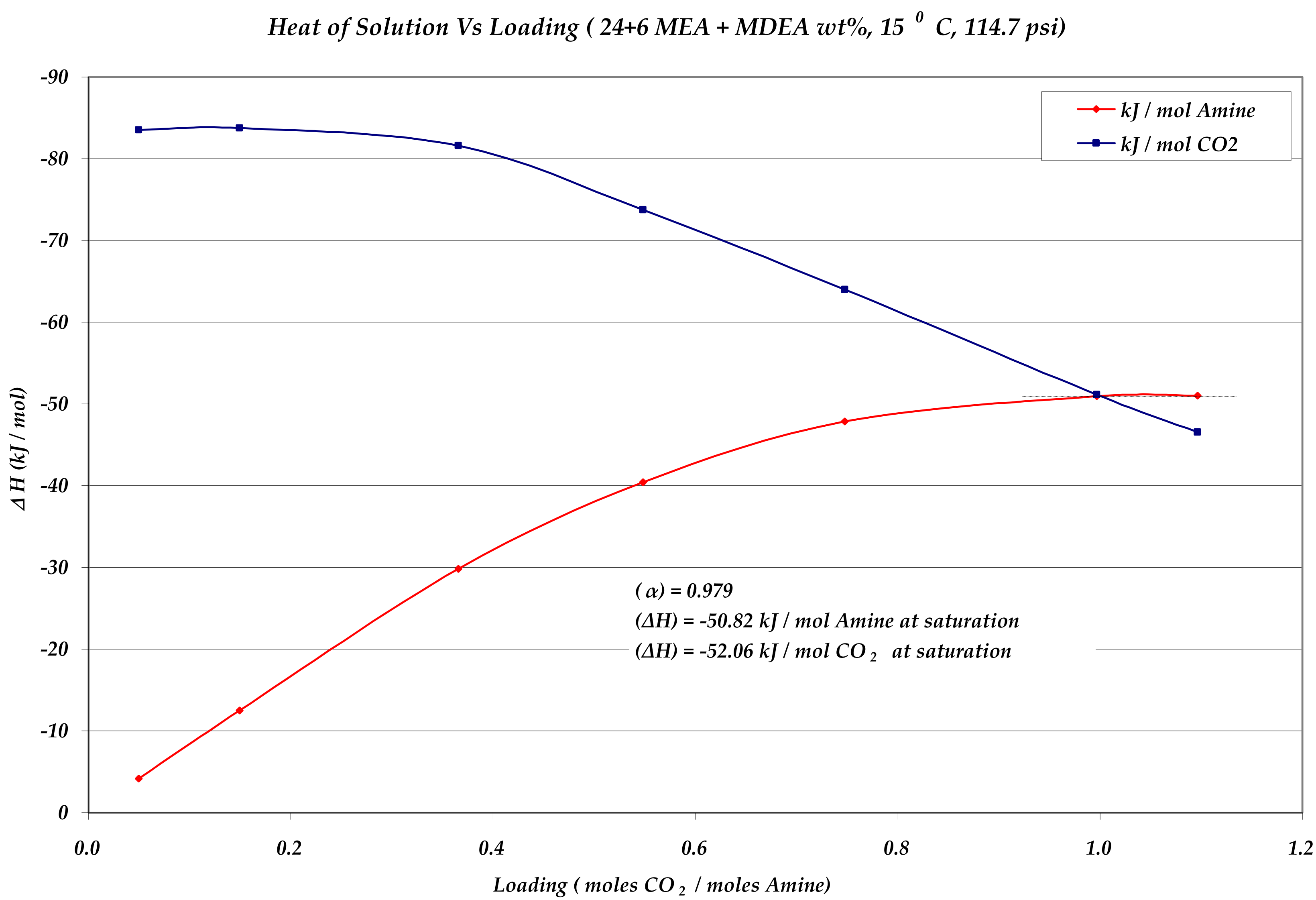

Figure 21: Enthalpy Vs Loading of CO_2 in (24+6) wt% MEA+MDEA solution at 15 ^{0} C and system pressure of 114.7 psi

Table 19: 24+6 wt % MEA + MDEA, 114.7 psi , 15 ^{0} C

CO_2 Flow Rate SCCM	CO_2 Mol/sec	Amine Flow Rate ml/min	MEA+ MDEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy ΔH (Average) kJ / mol Amine
0.50	3.7E-07	0.10	7.5E-06	0.050	-31.1	-83.54	-4.16
1.50	1.1E-06	0.10	7.5E-06	0.150	-93.5	-83.74	-12.52
1.10	8.2E-07	0.03	2.2E-06	0.366	-66.8	-81.63	-29.84
1.10	8.2E-07	0.02	1.5E-06	0.548	-60.3	-73.73	-40.42
1.50	1.1E-06	0.02	1.5E-06	0.748	-71.4	-63.98	-47.83
1.00	7.4E-07	0.01	7.5E-07	0.997	-38.0	-51.13	-50.97
1.10	8.2E-07	0.01	7.5E-07	1.097	-38.1	-46.52	-51.02

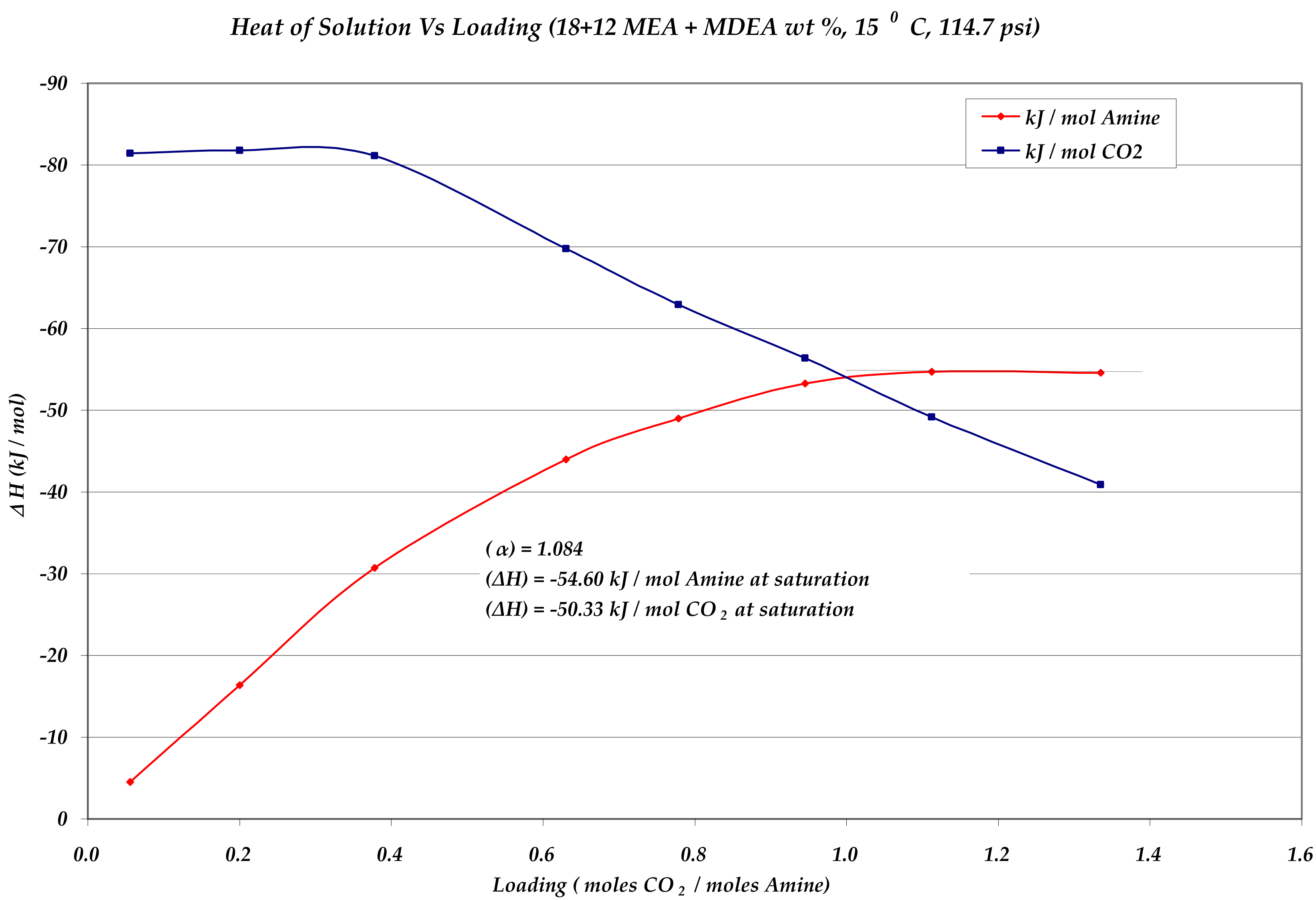

Figure 22: Enthalpy Vs Loading of CO_2 in (18+12) wt% MEA+MDEA solution at 15 ^{0} C and system pressure of 114.7 psi

Table 20: 18+12 wt % MEA + MDEA, 114.7 psi , 15 ^{0}C

CO_2 Flow Rate SCCM	CO_2 Mol/sec	Amine Flow Rate ml/min	MEA+ MDEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy DH (Average) kJ / mol Amine
0.50	3.7E-07	0.10	6.7E-06	0.056	-30.3	-81.44	-4.53
0.90	6.7E-07	0.05	3.3E-06	0.200	-54.8	-81.81	-16.38
1.70	1.3E-06	0.05	3.3E-06	0.378	-102.7	-81.16	-30.70
1.70	1.3E-06	0.03	2.0E-06	0.630	-88.2	-69.75	-43.97
1.40	1.0E-06	0.02	1.3E-06	0.779	-65.5	-62.90	-48.98
1.70	1.3E-06	0.02	1.3E-06	0.946	-71.3	-56.35	-53.28
1.00	7.4E-07	0.01	6.7E-07	1.112	-36.6	-49.17	-54.70
1.20	8.9E-07	0.01	6.7E-07	1.335	-36.5	-40.87	-54.56

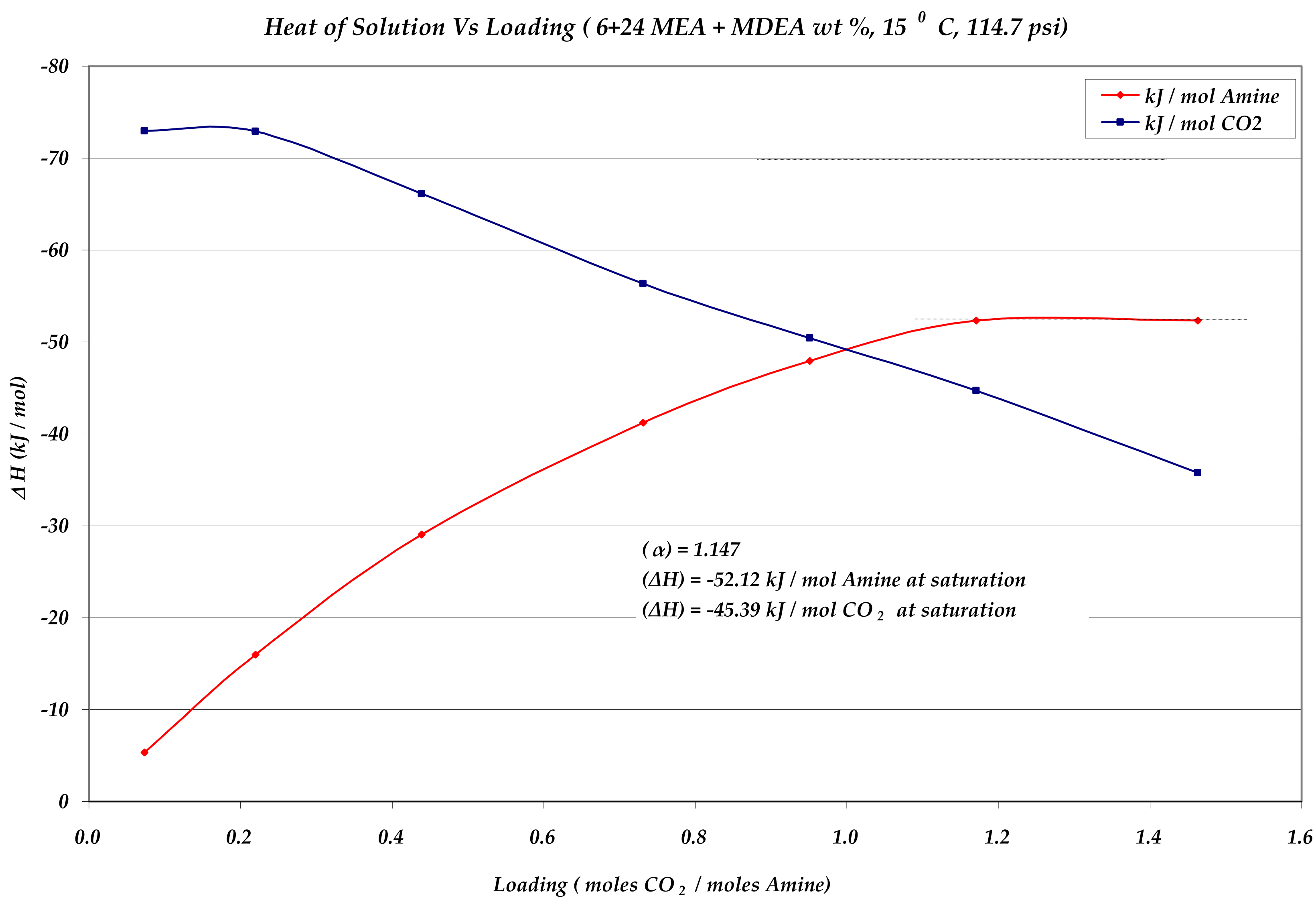

Figure 23: Enthalpy Vs Loading of CO_2 in (6+24) wt% MEA+MDEA solution at 15 ^{0} C and system pressure of 114.7 psi

Table 21: 6+24 wt % MEA + MDEA, 114.7 psi , 15 ⁰ C

CO_2 Flow Rate SCCM	CO_2 Mol/sec	Amine Flow Rate ml/min	MEA+ MDEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy ΔH (Average) kJ / mol Amine
0.50	3.7E-07	0.10	5.1E-06	0.073	-27.1	-72.97	-5.34
1.50	1.1E-06	0.10	5.1E-06	0.219	-81.4	-72.91	-16.00
0.90	6.7E-07	0.03	1.5E-06	0.439	-44.3	-66.16	-29.04
1.50	1.1E-06	0.03	1.5E-06	0.732	-62.9	-56.34	-41.21
1.30	9.7E-07	0.02	1.0E-06	0.951	-48.8	-50.43	-47.96
1.60	1.2E-06	0.02	1.0E-06	1.170	-53.2	-44.72	-52.35
1.00	7.4E-07	0.01	5.1E-07	1.463	-26.6	-35.77	-52.34

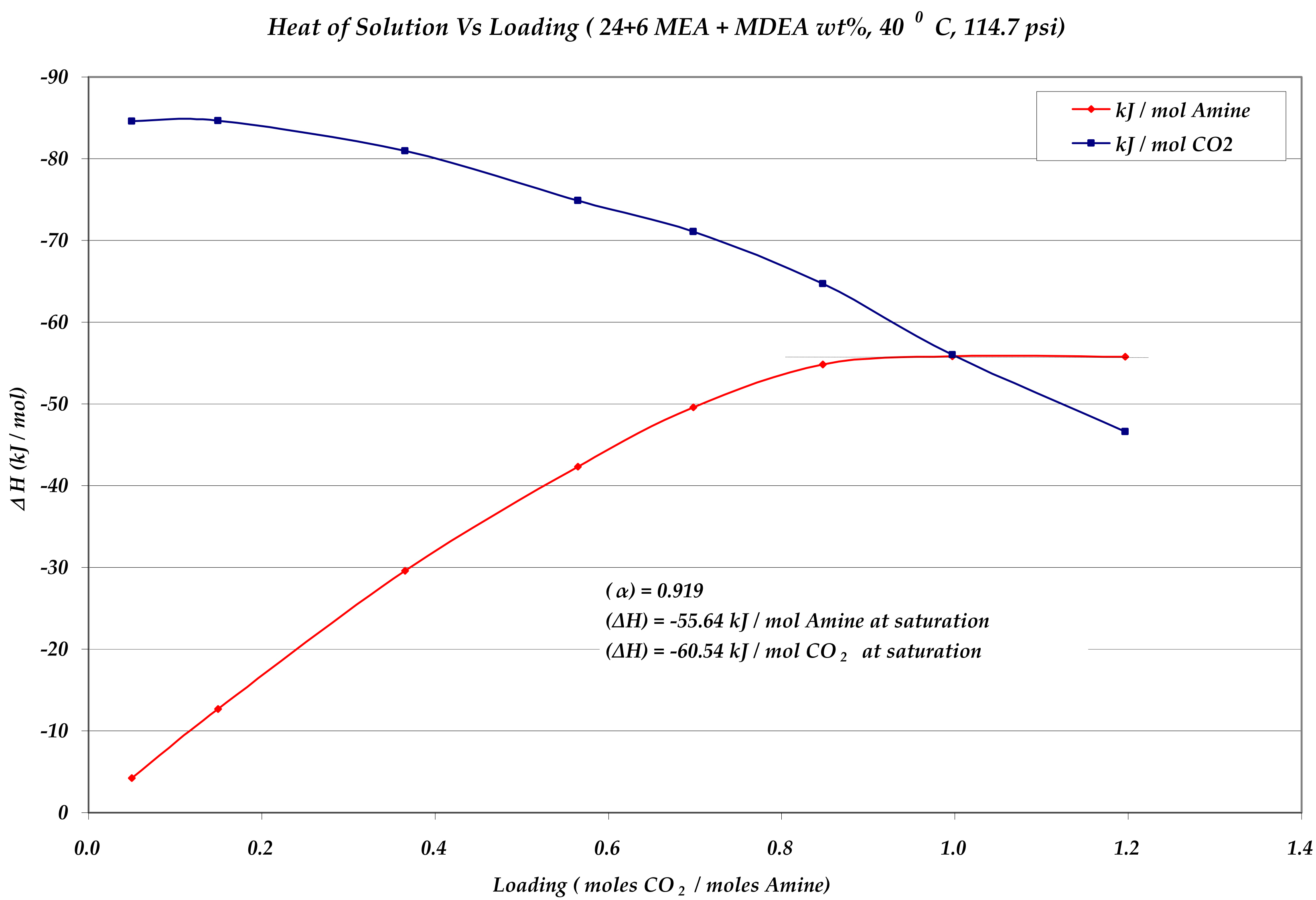

Figure 24: Enthalpy Vs Loading of CO_2 in (24+6) wt% MEA+MDEA solution at 40 ^{0} C and system pressure of 114.7 psi

Table 22: 24+6 wt % MEA + MDEA, 114.7 psi , 40 ⁰ C							
CO_2 Flow Rate SCCM	CO_2 Mol/sec	Amine Flow Rate ml/min	MEA+ MDEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy ΔH (Average) kJ / mol Amine
0.50	3.7E-07	0.10	7.5E-06	0.050	-31.5	-84.58	-4.22
1.50	1.1E-06	0.10	7.5E-06	0.150	-94.5	-84.63	-12.66
1.10	8.2E-07	0.03	2.2E-06	0.366	-66.3	-80.98	-29.60
1.70	1.3E-06	0.03	2.2E-06	0.565	-94.7	-74.90	-42.31
1.40	1.0E-06	0.02	1.5E-06	0.698	-74.0	-71.08	-49.60
1.70	1.3E-06	0.02	1.5E-06	0.847	-81.8	-64.70	-54.83
1.00	7.4E-07	0.01	7.5E-07	0.997	-41.7	-55.99	-55.82
1.20	8.9E-07	0.01	7.5E-07	1.196	-41.6	-46.61	-55.76

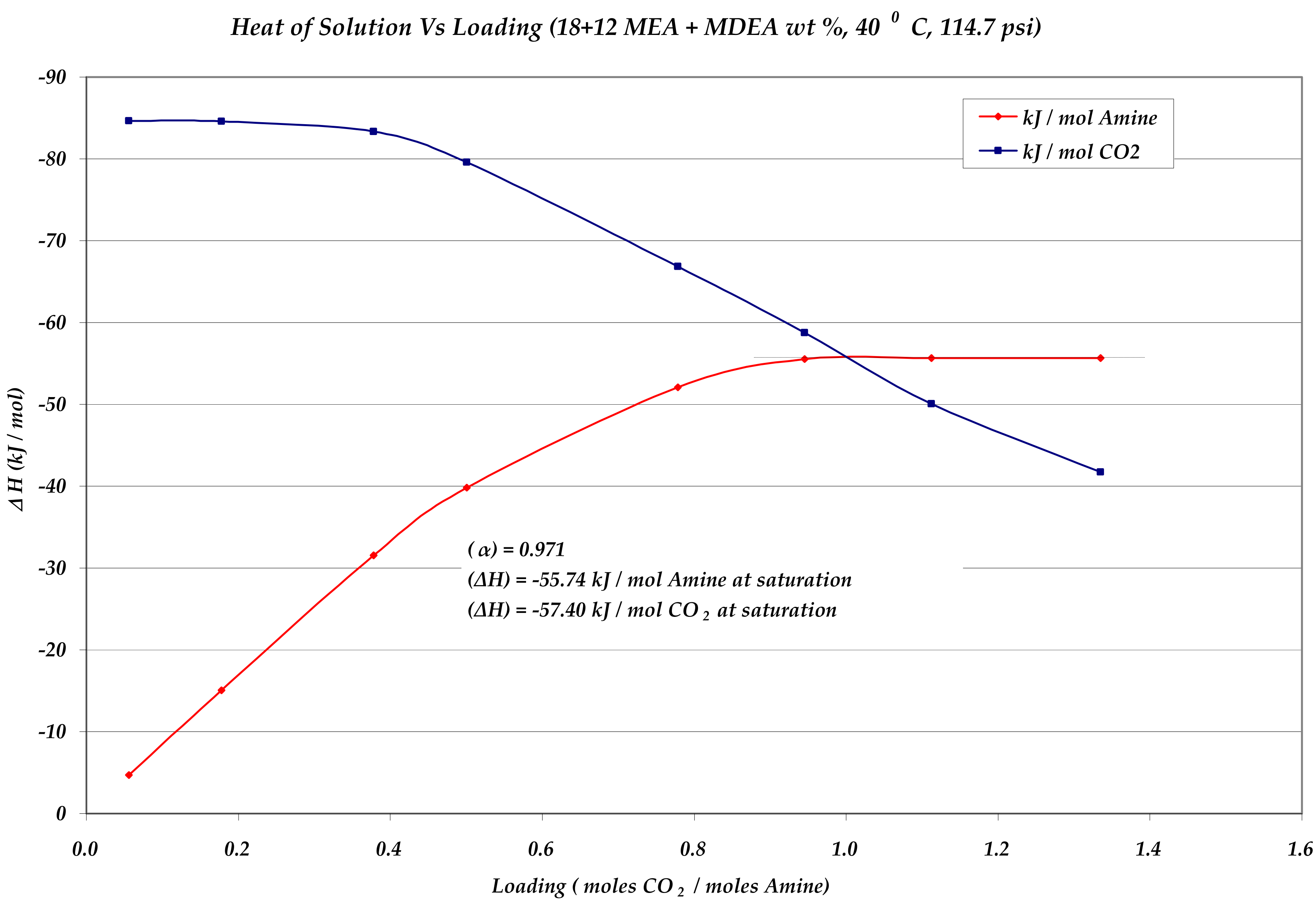

Figure 25: Enthalpy Vs Loading of CO_2 in (18+12) wt% MEA+MDEA solution at 40 ^{0} C and system pressure of 114.7 psi

Table 23: 18+12 wt % MEA + MDEA, 114.7 psi , 40 ^{0} C

CO_2 Flow Rate SCCM	CO_2 Mol/sec	Amine Flow Rate ml/min	MEA+ MDEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy ΔH (Average) kJ / mol Amine
0.50	3.7E-07	0.10	6.7E-06	0.056	-31.5	-84.63	-4.71
0.80	6.0E-07	0.05	3.3E-06	0.178	-50.4	-84.59	-15.06
1.70	1.3E-06	0.05	3.3E-06	0.378	-105.4	-83.34	-31.52
0.90	6.7E-07	0.02	1.3E-06	0.501	-53.3	-79.58	-39.84
1.40	1.0E-06	0.02	1.3E-06	0.779	-69.7	-66.87	-52.07
1.70	1.3E-06	0.02	1.3E-06	0.946	-74.3	-58.73	-55.53
1.00	7.4E-07	0.01	6.7E-07	1.112	-37.2	-50.05	-55.68
1.20	8.9E-07	0.01	6.7E-07	1.335	-37.2	-41.70	-55.67

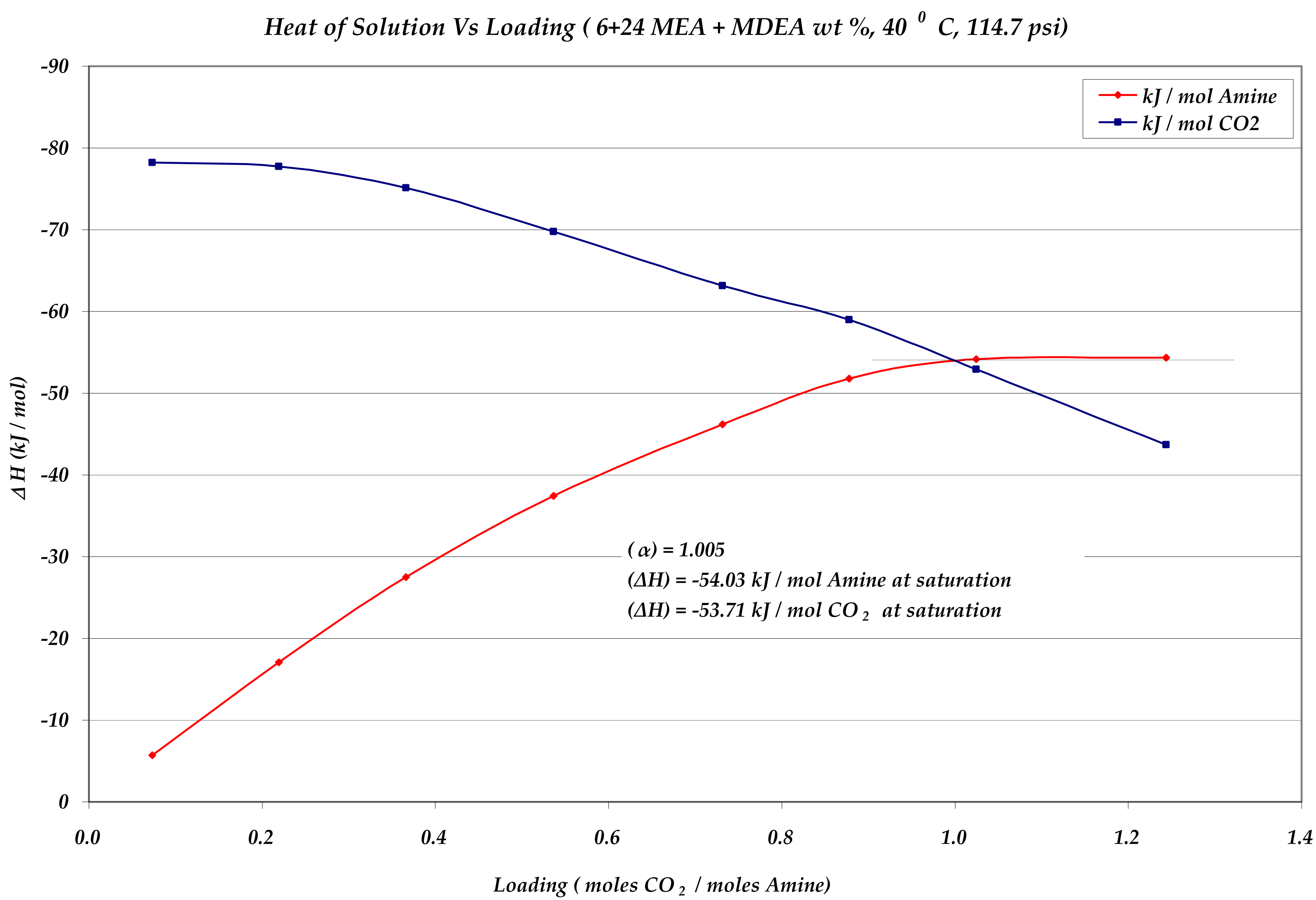

Figure 26: Enthalpy Vs Loading of CO_2 in (6+24) wt% MEA+MDEA solution at 40 ^{0} C and system pressure of 114.7 psi

Table 24: 6+24 wt % MEA + MDEA, 114.7 psi , 40 ⁰ C							
CO_2 Flow Rate SCCM	CO_2 Mol/sec	Amine Flow Rate ml/min	MEA+ MDEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy ΔH (Average) kJ / mol Amine
0.50	3.7E-07	0.10	5.1E-06	0.073	-29.1	-78.22	-5.72
1.50	1.1E-06	0.10	5.1E-06	0.219	-86.7	-77.71	-17.06
1.00	7.4E-07	0.04	2.0E-06	0.366	-55.9	-75.11	-27.48
1.10	8.2E-07	0.03	1.5E-06	0.536	-57.1	-69.76	-37.42
1.50	1.1E-06	0.03	1.5E-06	0.732	-70.5	-63.15	-46.20
1.20	8.9E-07	0.02	1.0E-06	0.878	-52.7	-59.00	-51.79
1.40	1.0E-06	0.02	1.0E-06	1.024	-55.1	-52.90	-54.18
1.70	1.3E-06	0.02	1.0E-06	1.244	-55.3	-43.71	-54.36

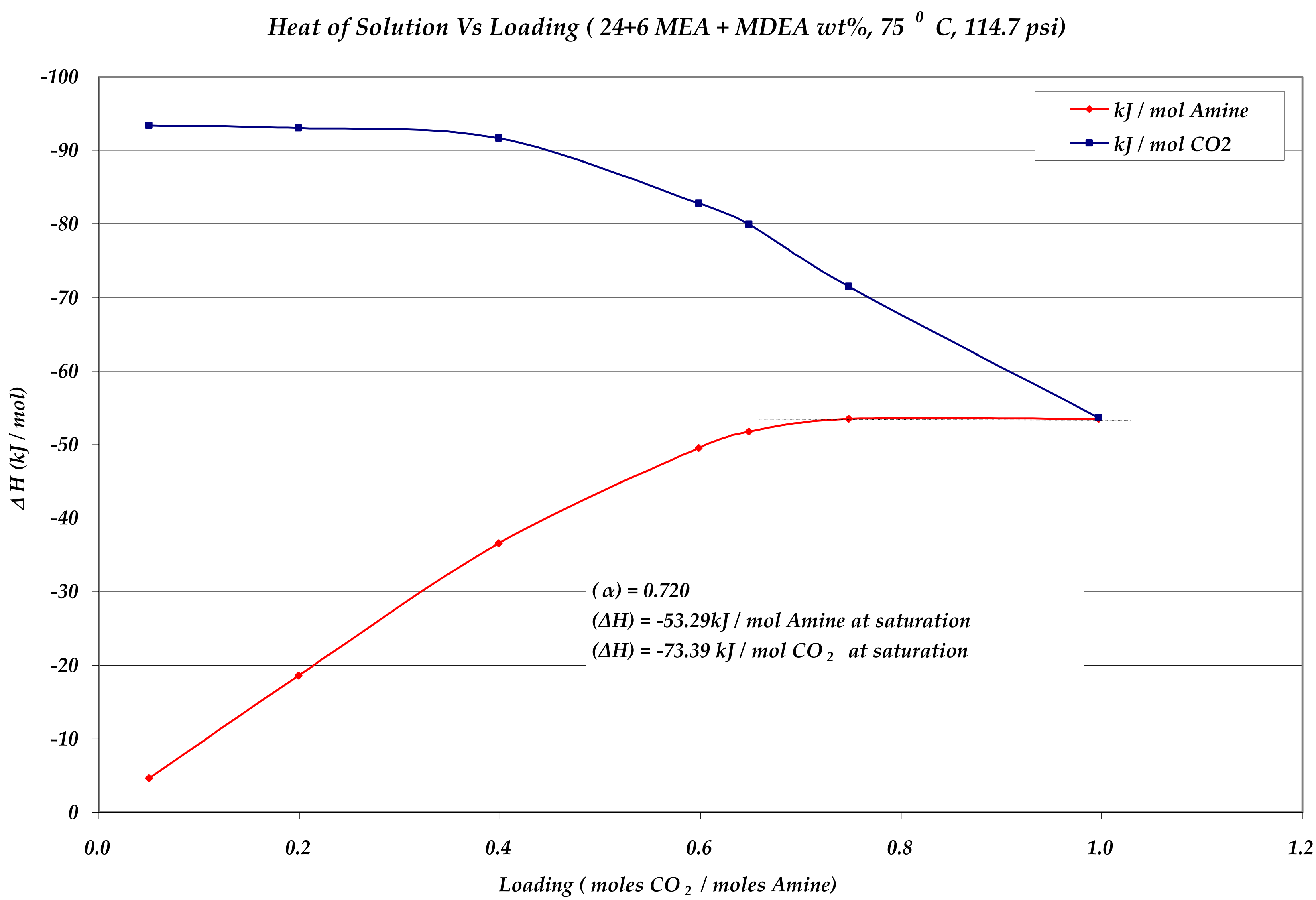

Figure 27: Enthalpy Vs Loading of CO_2 in (24+6) wt% MEA+MDEA solution at 75 ^{0} C and system pressure of 114.7 psi

Table 25: 24+6 wt % MEA + MDEA, 114.7 psi , 75 ^{0} C

CO_2 Flow Rate SCCM	CO_2 Mol/sec	Amine Flow Rate ml/min	MEA+ MDEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy ΔH (Average) kJ / mol Amine
0.50	3.7E-07	0.10	7.5E-06	0.050	-34.7	-93.36	-4.65
1.00	7.4E-07	0.05	3.7E-06	0.199	-69.3	-93.08	-18.56
1.20	8.9E-07	0.03	2.2E-06	0.399	-81.8	-91.66	-36.55
1.20	8.9E-07	0.02	1.5E-06	0.598	-73.9	-82.78	-49.51
1.30	9.7E-07	0.02	1.5E-06	0.648	-77.3	-79.96	-51.81
1.50	1.1E-06	0.02	1.5E-06	0.748	-79.8	-71.52	-53.47
1.00	7.4E-07	0.01	7.5E-07	0.997	-39.9	-53.64	-53.48

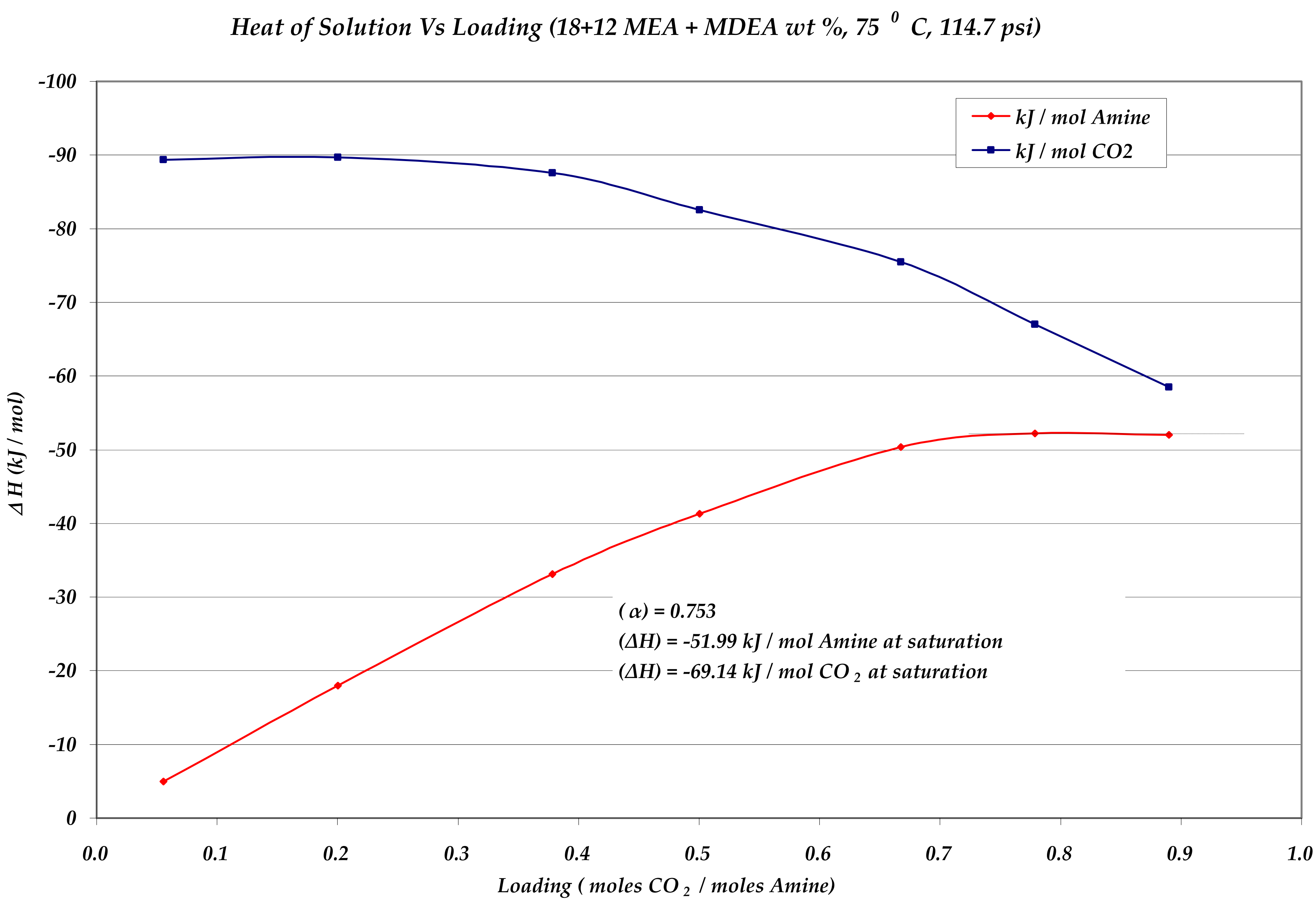

Figure 28: Enthalpy Vs Loading of CO_2 in (18+12) wt% MEA+MDEA solution at 75 ^{0} C and system pressure of 114.7 psi

Table 26: 18+12 wt % MEA + MDEA, 114.7 psi , 75 º C

CO_2 Flow Rate SCCM	*CO_2 Mol/sec*	*Amine Flow Rate ml/min*	*MEA+ MDEA Mol/sec*	*Loading of CO_2*	*Average Enthalpy mJ/sec*	*Enthalpy ΔH (Average) kJ / mol CO_2*	*Enthalpy ΔH (Average) kJ / mol Amine*
0.50	3.7E-07	0.10	6.7E-06	0.056	-33.2	-89.36	-4.97
0.90	6.7E-07	0.05	3.3E-06	0.200	-60.1	-89.69	-17.96
1.70	1.3E-06	0.05	3.3E-06	0.378	-110.8	-87.60	-33.13
0.90	6.7E-07	0.02	1.3E-06	0.501	-55.3	-82.53	-41.32
1.20	8.9E-07	0.02	1.3E-06	0.667	-67.4	-75.47	-50.38
1.40	1.0E-06	0.02	1.3E-06	0.779	-69.8	-67.05	-52.21
1.60	1.2E-06	0.02	1.3E-06	0.890	-69.6	-58.46	-52.03

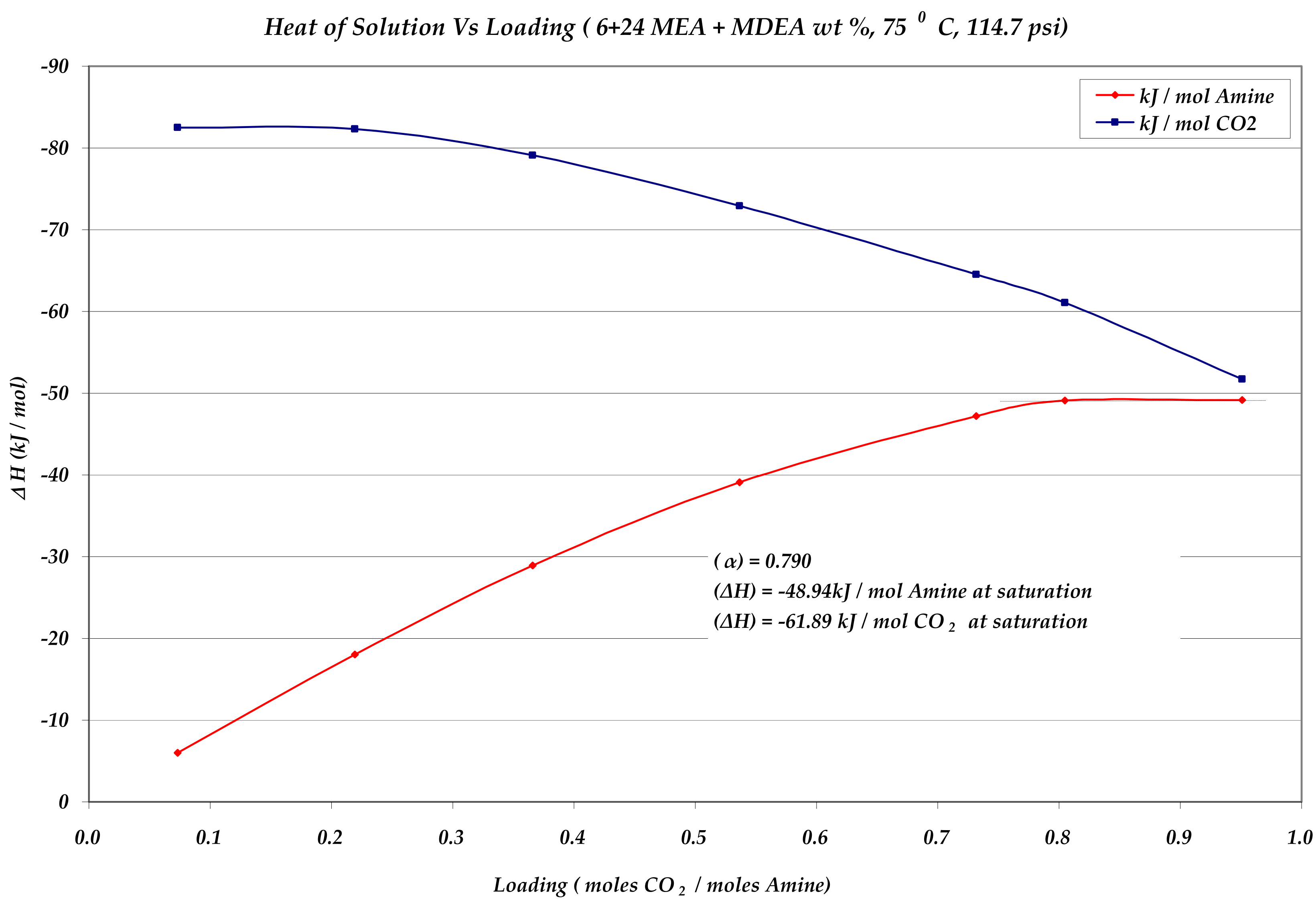

Figure 29: Enthalpy Vs Loading of CO_2 in (6+24) wt% MEA+MDEA solution at 75 ^{0} C and system pressure of 114.7 psi

Table 27: 6+24 wt % MEA + MDEA, 114.7 psi , 75 ⁰ C

CO_2 Flow Rate SCCM	CO_2 Mol/sec	Amine Flow Rate ml/min	MEA+ MDEA Mol/sec	Loading of CO_2	Average Enthalpy mJ/sec	Enthalpy ΔH (Average) kJ / mol CO_2	Enthalpy ΔH (Average) kJ / mol Amine
0.50	3.7E-07	0.10	5.1E-06	0.073	-30.7	-82.49	-6.03
1.50	1.1E-06	0.10	5.1E-06	0.219	-91.9	-82.31	-18.06
1.00	7.4E-07	0.04	2.0E-06	0.366	-58.9	-79.13	-28.94
1.10	8.2E-07	0.03	1.5E-06	0.536	-59.7	-72.94	-39.13
1.50	1.1E-06	0.03	1.5E-06	0.732	-72.0	-64.53	-47.21
1.10	8.2E-07	0.02	1.0E-06	0.805	-50.0	-61.06	-49.14
1.30	9.7E-07	0.02	1.0E-06	0.951	-50.0	-51.71	-49.18