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NLSD-71-8R

HIGH POWER CO LASER QUARTERLY TECHNICAL STATUS REPORT

1 Aug - 1 Nov 71.

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PROGRAM IDENTIFICATION (U)

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Program Code No.:	1E90
Name of Contractor:	Northrop Corporation
Effective date of contract:	1 August 1971 - 31 July 1972
Amount of Contract:	$537,699.00
Contract No.	N00014-72-C-0043
Program Manager:	Dr. G. Hasserjian (213) 675-4611, Ext. 4861
Project Scientist:	Dr. M. M. Mann (213) 675-4611, Ext. 2821
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TABLE OF CONTENTS (U)

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1.0 SUMMARY

(S) The purpose of this program is to develop, on an approximately two year time scale, a 1 - 2 MW average power variable pulse repetition rate diffraction-limited CO laser operating at an electrical efficiency of 50% or more. The work covered in this contract involves the design of intermediate power CO laser devices, the development of the required CO laser technology, and the construction of an intermediate power CO laser device.

(U) This program encompasses, on a best effort basis, the following major tasks:

(U) 1. The development of both steady state and transient kinetic models in order that realistic theoretical predictions of high energy device characteristics can be made.

(U) 2. Measurements of basic parameters of the CO laser at low pressures including: gain, saturation intensity, rates of vibrational cross-relaxation between CO molecules, transfer rates of CO and N_2, discharge characteristics, and spectral characteristics.

(U) 3. Measurements and characterization of a high pressure E-beam excited pulsed laser to experimentally determine transient operating parameters for high energy extraction.

(U) 4. The design and construction of a 500J/pulse diffraction-limited CO laser oscillator.

[redacted]

[redacted]

(U) 5. The development of mirror fabrication techniques for pulsed operation.

(U) 6. The development of line selection techniques for controlling the oscillator spectral output.

(S) 7. Preliminary design of a 20 KJ/pulse diffraction-limited CO laser oscillator-amplifier system.

(U) Significant progress has been made in this quarter of the program in all of the first six tasks reviewed above. A list of technical reports and published papers of completed work is given in the list of references at the end of this report.

(U) The cw kinetic model has been shown to be consistent with the low pressure gain measurements at the lower vibrational levels and a computer code of a preliminary transient model has been programmed.

(U) Measurement of small signal gain at liquid nitrogen temperatures has been completed up to v = 20 and comparison with the predicted values of the kinetic model is being made at the higher vibrational levels. Discharge measurements of the E-beam excited one liter device are now in progress after a lengthy redesign of the vendor supplied electron gun. Initial results indicate ionization levels of approximately 10^{12} electrons/cc with an E-beam current density of approximately 1.0 ma/cm^2. The discharge obtained shows excellent stability with CO and N_2 and adequate stability with CO and He for pulse durations up to 200 μs. Fluorescence power measurements, taken from room temperature down to -100°C, are in reasonable agreement with the predicted values of the kinetics code. The resonator optics of the device

[redacted]

are being mounted and the alignment technique has been tested with lasing of a CO_2 mixture.

(U) A 10 liter laser cavity is being considered for the diffraction-limited operation of a 500J/pulse laser. The detailed design of the cavity has been initiated, the 10 x 100 cm electron gun with 10 ma/cm^2 current density is under design, and the required power supplies have been ordered.

(U) A feasible technique of fabricating post-mounted thin substrate mirrors for pulsed operation has been tested by machining a small sized mirror from a block of copper alloy. Polishing and coating techniques have also been developed for finishing two alloys of beryllium copper. Instrumentation is being set up to test the reflectivity of the polished surfaces and measure substrate distortion introduced by flash lamp loading.

(U) Analytical and experimental work has been initiated to accurately characterize the absorption characteristics of a water vapor cell. This is the technique described in technical report NLSD 71-7R, December 1971, that is under consideration for the design of a line selection device for the high pressure pulsed laser oscillator.

(U) In the following sections of this report a more detailed summary of these results is presented.

2.0 TRANSIENT AND STEADY STATE KINETIC MODELING

(U) The development of the molecular kinetic model and computer program that was constructed to analyze the performance characteristics of a steady state electrically excited CO laser amplifier system is now reasonably complete. This program has been designed to calculate the vibrational population and temperature distribution of the CO energy levels by numerical solution of the master equation, and includes several different pumping and relaxation mechanisms, including stimulated emission. In addition, it also provides gain and saturation characteri stics, steady state extraction efficiency, and rates of energy transfer for all of the pumping and loss mechanisms present. Parametric calculations have been performed to show the effect of varying different experimental quantities, as well as to assess the sensitivity of different rate constants in the model. Preliminary comparisons with some experimentally obtained small-signal gain data from a low pressure amplifier has indicated that with physically realistic model constants, good agreement can be obtained. This comparison was reported in a paper presented at CLEA[1]. Further experiments involving small signal gain measurements are presently in progress, and are described below.

(U) The steady state kinetic model has been extended to include a transient analysis to permit calculations for short pulse high energy systems. This analysis includes all of the physics of the previous model, and allows predictions of amplifier characteristics as a function of time during the pulse.

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[1] M. L. Bhaumik, W. B. Lacina, and M. M. Mann, "Characteristics of a CO Laser," presented at CLEA, June 1971, Washington, DC; to be published in J. Quant. Elect., February 1972.

Preliminary calculations have already been completed, and indicate that multiline short pulse operation will have good energy efficiency as well as good power efficiency. Furthermore, the thermal loading is predicted to be only a very small percentage of the electrical energy input. The transient calculations indicate that, for multiline pulsed operation, it is reasonable to expect efficiencies of >70% for radiative extraction. Furthermore, the low heating rates during the pulse will make it possible to achieve a nearly uniform spectral output, and will minimize acoustic wave problems.

(U) These calculations will be extended to optimize the model to make it possible to obtain realistic predictions for a variety of operating conditions. It is also planned that steady state and transient analyses of an oscillator will be attempted in future work.

3.0 BASIC MEASUREMENTS AND COMPARISON WITH THEORY

(U) Several basic measurements are being performed to develop reliable analytical models and determine several basic constants of both the kinetic and discharge characteristics of the lasing gas. An extensive set of measurements of small signal gain have been made, cross-relaxation rate measurements have been initiated and plasma characteristics have been measured for a set of conditions of a low pressure laser. The experimental characterization of the high pressure laser has just been started and the results are described in the next section. A summary of some of the basic measurements is given below.

3.1 Small-Signal Gain Measurements

(U) In order to make comparisons between the theoretical steady state model and experiment, a series of small-signal gain measurements for a variety of controlled gas compositions at low temperature was undertaken. Preliminary data obtained for CO-He mixtures, varying the pressure of CO, has now been completed and further measurements in which the gas temperature or discharge current are varied will be carried out if required. A computer program has been constructed to calculate population densities and rotational temperatures, using a least squares analysis, from experimental gains measured for several vibrational-rotational transitions. Initial calculations, reported in a paper presented at CLEA, showed that with physically realistic choices of constants the kinetic model is able to give good agreement with experiment. Further comparisons with additional gain measurements will be undertaken shortly.

3.2 Cross-Relaxation Measurements

(U) The objective of the relaxation measurements is two fold: (1) to determine the probability of vibrational energy transfer from N_2 to CO, and (2) to measure the rate of cross-relaxation between particular vibrational levels of the CO molecules.

(U) A double Q-switching technique was employed to determine the $N_2 \rightarrow CO$ transfer rate by measuring the inversion recovery time. Proper concentration of the CO molecules was chosen so that the recovery time due to the CO-CO V-V relaxation was significantly shorter than that due to $N_2 \rightarrow CO$ transfer. The measured value of 10^{-3} for the transfer probability seems to be too high compared to the theoretical expectation. Therefore, the experimental arrangement is being modified to determine the rate more accurately.

(U) A three laser experiment is nearly complete for the vibrational cross-relaxation measurements. The gain in a particular vibrational-rotational transition will be monitored by an oscillator (with a grating as a cavity element) and amplifier combination. The third laser will saturate the gain in a neighboring vibrational band by means of a Q-switch pulse propagating in a spatially congruent manner with the gain probe beam. A telescope will be used to increase the intensity of the Q-switch pulse. After passage through the gain medium, the Q-switch pulse will be separated from the probe beam by means of another grating.

(U) The amplified signal exhibiting gain in a particular vibration band will change when a neighboring vibrational band is saturated by turning on the Q-switch pulse. The vibrational cross-relaxation will be determined from the rate of change of the amplified signal. The procedure will be repeated for various vibrational bands.

3.3 Characterization of the Electric Discharge

(U) An anlysis of the processes which control the electron density of an electron beam generated plasma has been nearly completed. The analysis, which predicts the electron density as a function of time for gas mixtures and discharge operating parameters of interest, considers the processes of ionization, recombination, charge transfer, attachment, and dissociation. In a study of this scope, obviously many questions can not be answered; however, we feel that the processes are sufficiently well described to allow one to design other discharges with confidence. A comparison of the calculated conductivity of the plasma with the measured conductivity shows favorable agreement. A sample calculation is given below.

(U) A discharge in pure nitrogen at 760 torr pressure, 0.55 mA/cm^2 electron beam current and 1.1 kV/cm sustainer field strength produced a sustainer current of 100 amperes. The calculation of the plasma parameters predicted an ion pair generation rate of 5.6×10^{17} $pairs/cm^3 sec$, and equilibrium electron density of $2.36 \times 10^{12}/cm^3$. The electron drift velocity for $E/p = 1.45$ V/cm torr (taken from S. C. Brown "Basic Data of Plasma Physics," 1966, pp 89) is 10^6 cm/s. This gives a calculated sustainer current density to be .38 a/cm^2, compared to the measured value of .37 a/cm^2 (discharge cross section of 300 cm^2). We do not expect, however, that our analysis is this accurate.

(U) Preliminary measurements of average electron density were also made on a low pressure discharge to support the analytical modeling of the cw kinetics.(about 10 torr). The electron density was measured by observing the shift in the resonance frequency of a microwave cavity. For typical laser gas mixtures and discharge parameters the electron density was of the order of $3 \times 10^9/cm^3$. A reduction in the electron density was affected by introducing oxygen, as expected. The ion saturation current as measured by a symmetric double probe inserted into the core of the discharge varied as the electron density over the discharge conditions. A preliminary measurement of electron temperature from the double probe voltage current characteristic showed values of about 2 eV. The problems of noise in the discharge, along with the collisional nature of the plasma, make these measurements quite uncertain.

4.0 EXPERIMENTS WITH AN E-BEAM EXCITED LASER

(U) An experimental E-beam excited CO laser device was constructed for parametric investigation of pulsed high pressure operating characteristics of various gas mixtures. The electron beam gun was designed and constructed by Physics International, Inc. with dimensions and characteristics with the least taxing requirements. In spite of this, the gun was not operational until extensive modifications were made, after delivery, over a period of three months. A review of the problems and results of experiments with this device is given below.

4.1 Description of Experimental Device

(U) The initial E-beam device employs an electron gun 3 x 100 cm in cross-section with a nominal output of 1 ma/cm^2. The discharge volume is nominally 1.5 liter. Pressure may be varied from 0 - 1 atmosphere. The device is cooled by immersion in a temperature controlled bath which is continuously variable from 77 - 300°K. The envelope is constructed of Invar to provide a low thermal impedance while minimizing problems associated with differential thermal expansion. Vacuum insulated ports are provided on the sides for diagnostic purposes. Provision has been made for mounting laser optics either internal or external to the plenum chamber. The basic parameters of the device are summarized in Table I.

4.2 Electron Gun

(U) The experimental program with the first E-beam device was delayed approximately 5 months due to late delivery and malfunctioning of the electron gun, associated power supply and pulser which were designed and constructed by Physics International.

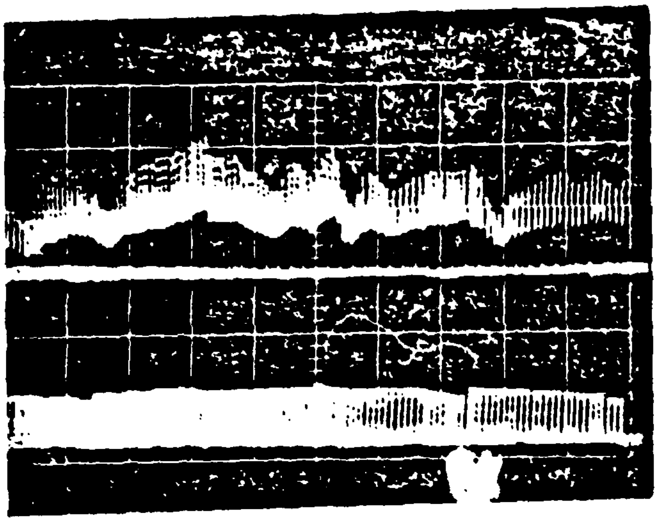
(U) Table I. Experimental Device Parameters (U)

Discharge Region	
Length	100 cm
Width	3 cm
Volume	1.5 liter
Temperature	77 - 300°K (continuously variable)
Pressure	<1 - 760 torr
Sustainer Supply	
Voltage	0 - 50 kV
Capacitance	40 μfd (50 kV) 160 μfd (25 kV)
Electron Gun	
Accelerating Voltage	0 - 180 kV
Current Density	0 - 1 ma/cm^2
Pulse Duration	20 - 500μs

(U) Extensive modifications to the gun were required in order to realize a minimum level of reliability and performance. This included redesign of the gun support assembly by P.I. and redesign and extensive reworking of the vacuum envelope, foil support, high voltage feedthrough, and gun pulser, by Northrop. In addition, the gun assembly was modified by Northrop to include a secondary grid to reduce field emission and vacuum breakdown problems.

(U) Considerable effort was also required to obtain satisfactory performance from the gun pulser. This included modification of the pulse deck by P.I. to obtain adequate grid pulse level, and modifications by Northrop to eliminate high voltage breakdown problems and improve the pulser reliability. Difficulty is still encountered with failure of the semiconductor logic elements in the pulser following a gun or cable spark, and erroneous triggering and multiple pulsing due to the use of low level triggers.

(U) Since completing these modifications it has been possible to obtain more than 100 shots at a time without failure. However, beam uniformity is still quite poor with random variations in current density of greater than 2:1. The axial current density profile as measured by a scanning probe is shown in Figure 1. The upper trace is the current density, while the total cathode emission current is recorded in the lower trace for calibration purposes. Each vertical bar represents an individual shot, and the length of the bars in the upper trace indicates the current droop for a 200 μsec pulse.



Upper Trace: Beam Current Density

Lower Trace: Total Emission Current (la/cm)

*arrows indicate base lines

Cathode Voltage = - 150 KV
Pulse Duration = 200 μsec

(U) Figure 1. Axial gun current density profiles. (U)

4.3 Discharge Measurements

(U) The initial experiments were devoted to investigating discharge characteristics to obtain data on electron density and discharge stability, and to optimize the discharge geometry.

(U) The range of experimental parameters is indicated in Table II. During these runs the sustainer voltage was limited by the standoff voltage of

(U) Table II. Discharge Measurements (U)

Constituents:	Ar, He, N_2, CO, CO_2
Sustainer Field:	0 - 4.0 kV/cm
E-Beam Current Density:	0 - 1 ma/cm^2
Pulse Duration:	20 - 500μs
Pressure:	100 - 760 torr
Temperature:	160 - 300^0K

the ignitrons in the crowbar which had not been adequately baked. The lower limit of the temperature range was due to a thermal problem with the seals on the plenum chamber which resulted in leaks and contamination of the gas as the temperature was lowered below 160^oK. These problems have been corrected and a more complete set of experiments is in progress.

(U) Experimental values of the electron density as determined from discharge impedance measurements at low sustainer voltages (~1 kV/cm), where secondary ionization processes may be neglected, were in excellent agreement with theoretical predictions. For typical high pressure CO laser mixtures with a primary current density of 1 ma/cm^2, the electron density is $>10^{12}/cm^3$.

(U) Problems with discharge stability and decomposition were encountered in CO and CO_2 mixtures containing an appreciable percentage (~50%) of helium. At atmospheric pressure and ambient temperature, the discharge tended to go into a self-sustaining mode at the termination of the gun pulse with sustainer fields >2kV/cm. In subsequent pulses with the same gas, the sustainer current would drop to a fraction of the initial value, and arcing would frequently occur indicating decomposition of the gas. The problem was more pronounced in He-CO_2 than in the He-CO mixtures. Since helium is not a required or particularly desirable gas constituent for high power CO lasers, this does not represent a significant limitation.

(U) No instabilities were detected in N_2-CO mixtures at temperatures below 200°K up to the maximum sustainer field which was available at the time (4 kV/cm).

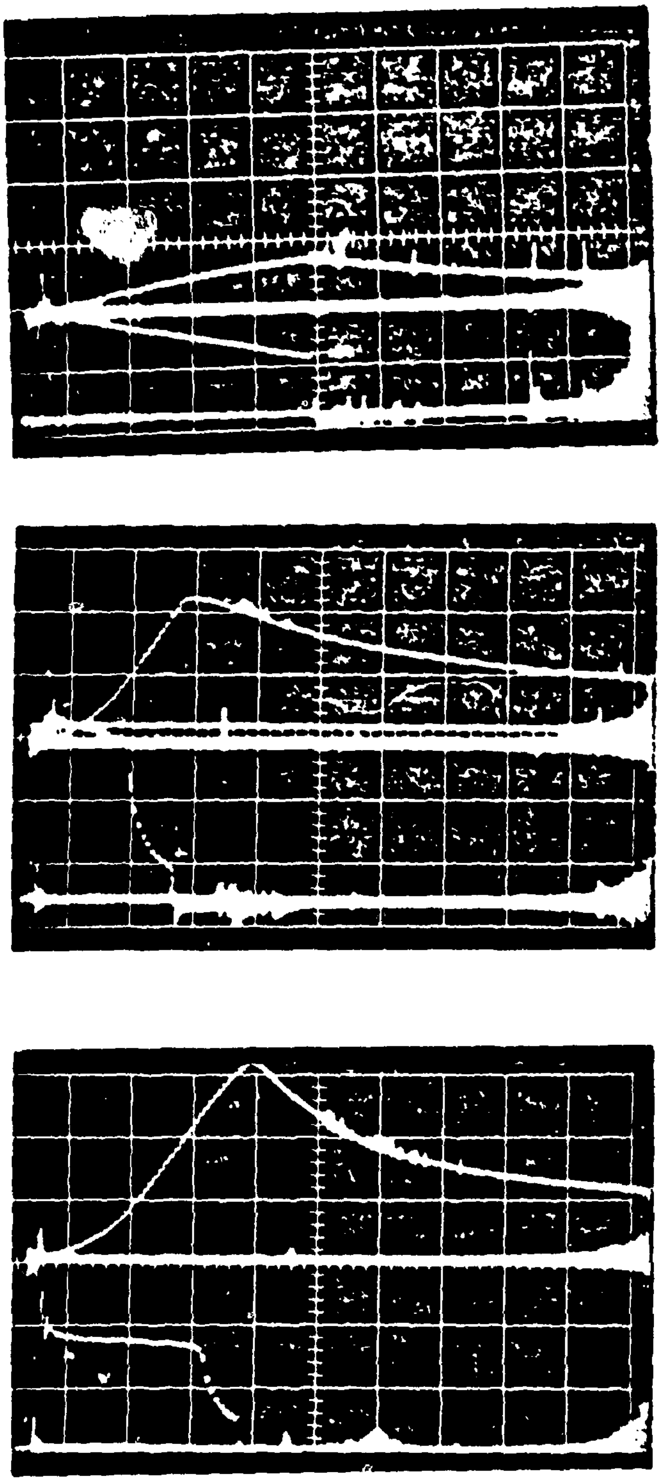
4.4 Fluorescence.

(U) Preliminary measurements of the CO output fluorescence were carried out. Figure 2 shows typical oscilloscope traces of the fluorescence observed at 25°C, -68°C and -111°C. The E-gun and sustainer voltages, the sustainer current and pulse duration measured from the oscilloscope traces were as follows:

Oscilloscope Trace	E-Gun Voltage	Sustainer Voltage	Average Sustainer Current	Sustainer Pulse Duration
Top	160 kV	5.5 kV	130 A	440 μs
Middle	170 kV	15.0 kV	520 A	150 μs
Bottom	170 kV	17.0 kV	350 A	270 μs

(U) The energy input to the gas (calculated from the sustainer voltage x sustainer current x sustainer pulse duration) and the relative fluorescence intensity as a function of the gas constituents and temperature are shown below.

Time, 100 μs/div.



T = 25°C

Fluorescence, 0.5 mV/div.

Sustainer Current, 100 A/div.

T = -68°C

Fluorescence, 2.0 mV/div.

Sustainer Current, 200 A/div.

T = -111°C

Fluorescence, 2.0 mV/div.

Sustainer Current, 200 A/div.

(U) Figure 2. Typical oscilloscope traces of the sustainer current pulse and CO fluorescence at temperatures of 25°C, -68°C and -111°C. (U)

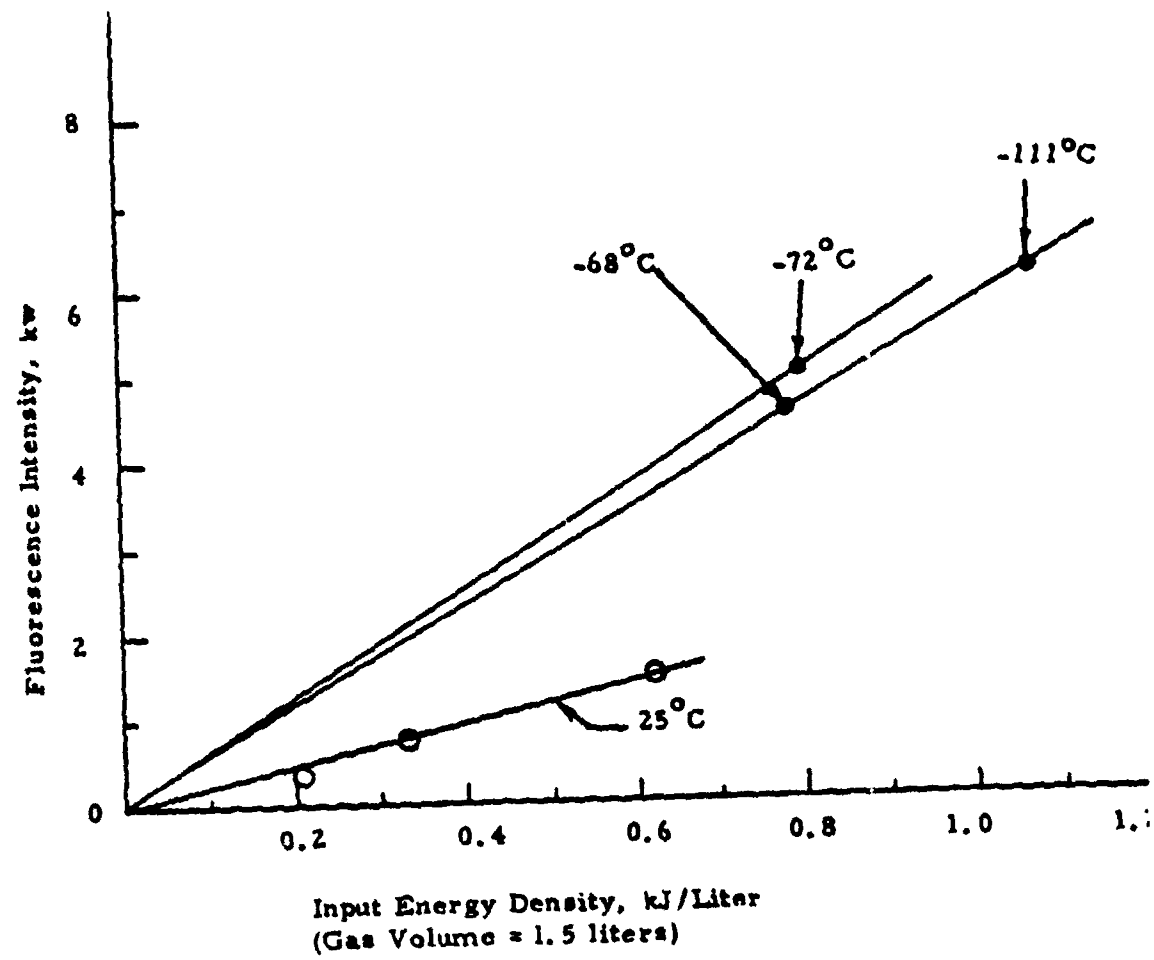
Oscilloscope Trace	Gas Constituents	Gas Temperature	Energy Input	Fluorescence Output
Top	250 torr of CO	25°C	315J	0.4 mV
Middle	250 torr of CO 500 torr of N_2	-68°C	1170J	4.6 mV
Bottom	250 torr of CO 500 torr of N_2	-111°C	1610J	6.2 mV

(U) The fluorescence output was measured at the front window using a gold-doped germanium, liquid-nitrogen cooled detector. The detector output may be converted to total fluorescence power by using the approximate conversion factor of 1500 W/mV. The resulting values agree with those predicted by a transient analysis within a factor of two, which is well within the experimental accuracy.

(U) Figure 3 shows the build-up of fluorescence intensity with increasing pump energy to the CO-N_2 gas at room temperature and at low temperatures of -68°C to -111°C. Note the significant increase of about a factor of 2.5 at cold temperatures. Fluorescence lifetimes at cold temperatures for a 250 torr CO-500 torr N_2 mixture was typically 700 μsec compared with about 500 μsec at room temperature for 250 torr of CO.

4.5 Optics

(U) The cryogenic operating temperatures of the CO laser impose special constraints on the laser optics. In order to minimize problems with thermal gradients inside the laser resonator, the original optical assembly employed mirrors internal to the plenum chamber which were mounted on a mechanically isolated invar support system. The rear mirror is a Laser Optics Inc., 100%



(U) Figure 3. Fluorescence output intensity versus input energy density to CO-N_2 gas at room and cold temperatures. (U) reflectivity, 2-inch diameter, spherical mirror with a radius of curvature of 10 meters. The output reflector of the laser resonator is a Laser Optics Inc., 2-inch diameter germanium plane mirror multidielectric coated for 90% reflectivity on one surface and antireflection coated on the other surface for wavelengths of 4.8 to 5.4 microns.

(U) When the plenum chamber was cooled down to temperatures of -100°C to -140°C during flourescence output measurements of CO and N_2 mixtures, the following effects were observed:

(U) 1. The rear mirror had become extremely astigmatic as observed using the specular beam return of the alignment helium-neon laser beam. The astigmatism observed is sufficient to prevent laser action and is attributed to high spots on the diameter of the mirror which was mounted too snugly, thus leading to mirror distortion. Also, the Invar mount used for this mirror does not compensate for thermal expansion (compression) effects at low temperatures.

(U) 2. In cooling down the plenum chamber from room temperature to -140°C, the rear mirror and front window had misaligned by approximately 2.4 milliradians with respect to the helium-neon alignment laser beam. Differential expansion of the entire plenum chamber (and E-gun assembly) and support structure caused the laser optical axis to point down by this amount.

(U) To avoid these problems, both resonator mirrors are being located external to the plenum chamber and a helium-neon alignment beam transmitted by the CaF_2 windows will be used to monitor the plenum optical axis at all times. The external surfaces of the windows are kept moisture free with a continuous flow of dry nitrogen.

(U) To test the experimental system and the optics alignment technique, a CO_2-N_2-He mixture of 1:2:3 was tested for lasing. At 10 kV sustainer voltage and 300 amp of sustainer current, strong CO_2 lasing was observed. The reflective coating of the 10% output mirror disintegrated, and ablation of the germanium substrate was observed. It is estimated from damage threshold values that the output energy was in excess of 20J.

5.0 MODE CONTROL AND LINE SELECTION STUDIES

(U) The purpose of these studies is to generate a cavity design for the high power CO laser that will produce nearly diffraction-limited operation at wavelengths having minimum atmospheric absorption. Thus the components required for line selection must be integrated with the high Fresnel number optics forming the laser resonator.

5.1 Cavity Design and Computer Program

(U) During this period considerable effort has been directed toward optimizing the basic unstable resonator configuration. Unstable optics were chosen primarily because they have a large mode volume with resulting laser action throughout the entire excited volume. This maximizes the energy extraction and effectively cools the gas by removing energy through stimulated emission. Also, the unstable resonator configuration provides better discrimination against multimode operation than stable resonators, especially for systems with high Fresnel numbers.

(U) Normally it is desirable to operate with a small cavity Fresnel number because it is easier to achieve single-mode operation and the mode is less sensitive to medium perturbation. In order to gain the advantages of small Fresnel number cavities while maintaining large excitation volumes a compound resonator has been designed, consisting of two concentric unstable resonators. The inner resonator is small in diameter and has a relatively low coupling coefficient compared to the large outer resonator. Thus oscillation will occur first in the inner oscillator and a fraction of the energy will be injected into the outer resonator where it is amplified. Since the resultant intensity profile is determined by the inner oscillator (which has a small Fresnel number), single-mode operation with a nearly diffraction limited beam should be easier to achieve.

(U) A computer code has been written which provides the normal mode patterns and resultant far-field diffraction patterns for general resonator configurations, provided that the Fresnel number is no greater than 25. A saturable gain medium is included by lumping the gain into either one or two increments. Also, arbitrary radial variations in the initial gain can be included. Variations in the refractive index of the active medium will be incorporated as the next step.

(U) Basically, the program assumes an initial intensity distribution (which is arbitrary) and then iterates by using the computed field intensity, obtained by performing a Huygens-Fresnel integration, as the source for the next calculation. It has been shown that gain saturation may have a striking effect on both the phase and intensity profiles.

(U) The computer program is presently being used to compute intensity and phase profiles for the inner resonator described above. The results to date show that the profiles vary considerably with the coupling coefficient, the Fresnel number, the gain parameters and the degree of truncation introduced. These calculations will serve as the basis for the design of the first experimental unstable resonator optics.

5.2 Line Selection Technique Development

(U) During this period the development of the spectral line selection technique for high power carbon monoxide lasers was initiated. The direction of the effort was based on the preliminary results obtained by this department and reported separately.

(U) Since water vapor is the major contributor to atmospheric absorption of 5 micron radiation, the goal of the program is a line selected high power carbon monoxide laser utilizing an internal water vapor absorption cell. In order to allow oscillations only on transitions which have a high transmittance through the atmosphere, control of many parameters is required. Introducing a selective loss mechanism by means of the absorption cell requires control of (1) temperature and content of the water vapor, (2) type and amount of broadening gases, (3) type and amount of other atmospheric absorbing gases. An experimental and theoretical investigation of the interaction of the carbon monoxide laser radiation with water vapor was begun in order to obtain the information necessary for the design and implementation of an operable device.

(U) A literature search indicated that no previous investigators had experimentally analyzed the water vapor absorption to the high resolution required to interpret the 5 micron laser radiation interactions. Thus, during this period the major portion of an experimental set up was completed which will provide measured parameters and controllable variables required for the design of absorption cells. The setup involves a low pressure carbon monoxide laser, an internal absorption cell with means to control the various mechanisms discussed above, a diffraction grating which will allow investigation of the parameters for each pertinent spectral line, and various peripheral equipment.

(U) A computer model was completed which will provide the theoretical support for the experimental portion of the program. The model presently permits analysis of the monochromatic absorption of radiation by water vapor as a function of the temperature and content; it also includes the line broadening effects of nitrogen. The model can also be modified readily to include effects of additional gases, such as broadening and absorption mechanisms.

6.0 PULSED MIRROR DEVELOPMENT

(U) Work for the past quarter was devoted to analytical prediction of surface distortion, fabrication of multipost supported faceplates, and polishing of candidate mirror alloys. Results to date indicate that we will be able to fabricate mirrors which remain diffraction limited under pulsed loadings of more than the energy density of the 500J/pulse device The effort for the forthcoming quarter will concentrate on refining the analytical prediction, fabrication and polishing techniques, the development of experimental set ups and fabricating the first set of optics for an experimental unstable resonator.

(U) Analyses have been formulated for overall bending of the mirror structure and the local distortions associated with a thin, post supported faceplate. For ease in analysis, the mirror has been modeled as a one-dimensional structure. Predictions from this model of bending frequencies and deflections should be within $\pm$ 15% of the actual value and calculations are greatly simplified by this procedure. Local distortions of the post-supported faceplates have been similarly modeled by a one-dimensional beam with similar anticipated errors in predicted deflections and slopes of the mirror surface. The analyses have been incorporated into simple, efficient computer programs.

(U) In modeling the local distortions of a post supported faceplate, two approaches were used. For a check solution, the faceplate-post structure was modeled as a continuous, 1-D beam on a uniform elastic foundation. This case corresponds to a very large number of posts per unit length of the beam. The second approach consists of modeling the beam-post structure by the finite element approach. This approach shows the effect of varying post number and spacing. With the use of the continuous model, one can determine the point of diminishing returns in terms of increasing the number of posts -- an important factor in reducing fabrication cost of the mirror.

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(U) The first quarter effort on the High Power CO Laser Program is reviewed. The program is directed toward the development of the required CO laser technology, the required component technology and the design and construction of intermediate power laser devices. The results of analytical and experimental investigation of the basic characteristics of the laser are reviewed and initial data from a high pressure electrically excited CO laser device are discussed.

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