

TECHNICAL NOTE 01-00
Filling of the X-10 BRD and Model 5 ProtectoJet Units
Use of Nitrogen vs. CO₂ as the Propellant
Dated 8/11/00

Introduction

Several institutions have called Hydro-Force asking whether the X-10 and Model 5 units can be filled with Nitrogen gas rather than the recommended Carbon Dioxide gas. In order to properly answer the questions, we have compared the characteristics of the two gasses and we have test fired both the X-10 and the Model 5 with each gas and compared the results.

Summary

The CO₂ gas appears to be a far better propellant for both the X-10 and the Model 5 because both units are high-pressure foggers. The nitrogen will work as a propellant but the number of shots and the fogging effect of the spray are not as good. Neither unit will provide the specified number of chemical bursts with a Nitrogen propellant. We recommend that Nitrogen be used as a propellant only under emergency conditions. Compressed air can also be used in the same emergency conditions. However, the operator must recognize that the number of shots will be reduced and the chemical will leave the unit in more of a stream rather than a fog. The reduced number of shots also means there is more chemical solution being delivered in each shot.

Compressed Gas Information

1. Nitrogen and Carbon Dioxide are both stable gasses that exist in our atmosphere. Each has been used as a compressible fluid and as a propellant in less lethal weapons.
2. Carbon dioxide becomes liquefied at a relatively low pressure at room temperature making it a more compressible gas. This means that a pound of CO₂ will expand to fill a larger volume at room temperature than Nitrogen. For example, 20 pounds of CO₂ will expand to fill approximately 181 cubic feet while the same 20 pounds of Nitrogen will fill approximately 51 cubic feet.
3. Carbon dioxide is liquefied at room temperature with about 800-900 psi pressure while Nitrogen needs special tanks and equipment to be liquefied. Therefore, when you are filling your unit, some of the CO₂ will be liquid further increasing the gas expansion when the unit is operated.
4. As your chemical tank is emptied, the CO₂ being more elastic provides a more consistent pressure over more shots, resulting in more shots with good propellant pressure for each.

5. A Nitrogen bottle typically has a filled pressure of approximately 2400 psi, which requires the use of special valves and a regulator to obtain filling pressure.
6. A Carbon Dioxide bottle typically has a filled pressure of about 800 psi, which allows you to fill X-10 and Model 5 units without an additional valve or regulator.

Results of Testing

1. The purpose of this testing was to directly compare the operation of both the X-10 unit and the Model 5 unit while changing only the propellant from Carbon Dioxide gas to Nitrogen gas. Therefore, all other variables were kept the same including the equipment used, the measuring gauges, and the filling pressures.
2. For purposes of this test water was used as the chemical solution. The tests were conducted at midday under normal daytime air temperatures. The units were filled and fired first one then the other on the same marked course.
3. The chemical spray was examined for the number of shots, the distance of the shots and the spray pattern of the shots. All tests were conducted using two different shooting individuals and the results compared.

X-10 Testing

<u>Shot No.</u>	<u>Shots of CO₂</u>	<u>Shots of Nitrogen</u>
1	15	
2	13	
3	14	
4		7
5		8
6		7
Average:	14	7.3

1. The first two shots using Nitrogen always resulted in a streaming flow rather than a fog.
2. The initial stream force was about the same for both propellants but fell off sharply for the Nitrogen.

Model 5 Testing

<u>Shot No.</u>	<u>Shots of CO₂</u>	<u>Shots of Nitrogen</u>
1.	14	
2.	14	
3.	13	
4.		7
5.		9
6.		9
Average:	13.6	8.3

1. The 55 ft. shooting distance was about the same for each propellant.
2. The spray pattern was smaller with the Nitrogen than with the CO₂.

Conclusion

Carbon Dioxide gas is the best propellant gas to use with both the X-10 BRD and the Model 5 ProtectoJet. Carbon dioxide may also be a safer filling gas because of the lower filling bottle pressure. Some institutions currently have Nitrogen gas cylinders but no Carbon Dioxide cylinders. These institutions should obtain a Carbon Dioxide gas cylinder from the same supplier that provides the Nitrogen gas service. Carbon Dioxide gas is available from many different suppliers since both the welding industry and the beverage industry uses it. A 50 lb. Carbon Dioxide cylinder is recommended because it will usually provide over 40 recharge fillings of either the X-10 or the M-5. The refilling kits provided for both the X-10 and the M-5 provide all equipment needed for filling other than the Carbon Dioxide gas bottle.

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